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THE UNIVERSITY OF ALBERTA

MAP TYPES AND RELATED WEATHER OVER THE MACKENZIE VALLEY

by

© PETER ROSS SCHOLEFIELD

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

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FALL, 1976

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Map Types and Related Weather Over the Mackenzie Valley", submitted by Peter Ross Scholefield in partial fulfilment of the requirements for the degree of Master of Science in Meteorology.

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Date 12 July 1976

DEDICATION

This thesis is dedicated to
my loving wife, Heather
son, Scott
and
daughter, Melina

ABSTRACT

Knowledge of the relationship between synoptic surface weather-map patterns and various weather parameters is fundamental to the production of an aviation forecast. A sound training in atmospheric dynamics, combined with actual forecast experience, enables a forecaster to obtain an understanding of this complex relationship. Statistical information, based on historical data, would be a useful aid to the aviation forecaster in that it would objectively expand his knowledge gained through experience. This thesis examines the relationships between objectively determined surface map types and associated weather. Percent probabilities of occurrence of aviation weather parameters associated with the map types are calculated, and those for ceiling and visibility categories are used as a simple conditional-probability forecast model. The map-type forecasts are tested against pure climatological forecasts using an independent data sample.

A catalogue of surface map types occurring over the Mackenzie River Valley during the three coldest winter months is developed from 27 years (1946-1972) of MSL grid-point pressure data. The computerized correlation methods developed by the United States Air Force (USAF) at Colorado Springs were used to produce the catalogue. The catalogue comprises a summary of the occurrence and pressure characteristics of map types in addition to a chronological listing of the types assigned to each of the 3814 maps in the data

base. Interesting relationships between map types in the catalogue and climatic anomalies at Yellowknife are presented.

Twenty years (1953-1972) of hourly weather data for Yellowknife are used to examine the relationships between map types and aviation weather parameters. Percent probabilities of occurrence of ceiling and visibility categories, precipitation, wind speed and wind direction, associated with map types, are calculated from the first 16 years of hourly data. The conditional probabilities of ceilings and visibilities are used to forecast these same parameter occurrences during the four years 1969-1972. Map-type forecasts were generally better than pure climatological forecasts over this period. Poor forecast reliability, caused by over-stratification of the data, emerged as a major problem when the map types were stratified by pressure gradient. Methods to improve reliability and some suggestions are presented.

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I am indebted to my former United States Air Force colleagues of the 12th Weather Squadron Map-Typing Project Office in Colorado Springs. My association with them made this thesis possible. Special thanks go to Dick Nieman and Terry Cherne who provided me with the MSL pressure data upon which this study is based.

I wish to thank my employer of the Atmospheric Environment Service for granting me a leave of absence and generously providing financial support during my three years of graduate study.

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CHAPTER I

INTRODUCTION

1.1 Statistical Weather Prediction by Correlation Methods

With continued advances of computer technology into the field of meteorology there has been increasing interest in the development of statistical weather prediction techniques. Two of the more common approaches to the development of probabilistic forecast aids are through the development of regression equations and through the association of weather with map patterns. A desirable feature of the map pattern approach is that it conforms to the traditional forecasting practice of relating weather parameters to synoptic map patterns. Until recently this approach has been hampered by the subjectivity required in the identification of similar map patterns or types.

The objective correlation technique, developed by Lund (1963)* and later modified by the USAF, has been used in several studies to classify and identify weather map types. It entails calculating the simple linear correlation coefficient between the values of a specific meteorological quantity on a weather map and those values at the same location on other weather maps. Maps that are highly correlated with each other are grouped into designated types. Those maps that

do not correlate highly with any of the maps are assigned to an uncorrelated group. This group may also contain some maps that correlate highly with only a few maps which, when taken as a group, are not numerous enough to constitute a type.

Once the maps have been grouped into types, climatic data from within the map-type region are used to study the relationships between weather phenomena and the map types. Most of these correlation studies have involved the relationship between precipitation and map types (Augulius, 1969 and 1970; Hartranft et al., 1970b; Paegle and Kierluf, 1974; Kociuba, 1974; Paegle and Wright, 1975).

1.2 USAF Applications of Map-Type Climatology to the Prediction of Visibilities and Ceilings

The incorporation of objective map-type classification and identification techniques into the statistical prediction of ceilings and visibilities was proposed in the United States Air Force (USAF) publication on map typing by Hartranft et al. (1970a) in Colorado Springs. They suggested the development of seasonal, surface map-type catalogues for six designated areas or "windows" across the continental United States (CONUS). It was believed that stratifying conditional climatology tables (CC) according to the catalogued map types would improve this type of objective forecast aid by incorporating the causitive synoptic situation into these purely climatological tables.

CC tables give the climatological probabilities of the ceiling and visibility categories occurring at selected time

intervals after an initial time when the initial categories are given. The standard tables are usually stratified by season and time of day. Restivo (1966) elaborates on the development of these tables which are also referred to as persistence probability tables. CC tables were produced for several of the winter map types in the Great Lakes window using November hourly weather data from Duluth, Minnesota. Results based on the dependent data sample showed that map-type-stratified, conditional climatology (MTCC) tables offered a significant improvement over the standard CC tables.

After two years of continued research of map-typing concepts, refinement and documentation of development techniques at Colorado Springs (Sabin, 1972; Sabin and Nieman, 1972; Scholefield, 1972 and 1973a; Wold, 1973; Sabin, 1974) a map-type forecast system was officially proclaimed by the USAF Air Weather Service in June of 1972 (Scholefield, 1973b). A Map-Typing Project Office was established at Colorado Springs which produced map-type catalogues for fourteen CONUS windows, two in Europe and one for Japan. MTCC tables were produced from these catalogues for several USAF forecast offices. It had been planned to incorporate MTCC into the USAF Global Weather Center's automated terminal forecast model as a climatological check in the forecast procedure. CC tables stratified by wind direction (WSCC) were currently being used for this purpose.

1.3 Verification Results

In 1974, at Colorado Springs, a verification procedure was carried out using two years of independent data to compare the

performance of CC, MTCC and WSCC models in the forecasting of ceiling and visibility categories. Tables were developed from thirteen to sixteen years of dependent data. Contingency tables were constructed for the three forecast models and for a persistence model. Skill scores were calculated for each model against chance and persistence. The overall results showed little difference between the four models. The results of this verification have not yet been published, but they indicate that stratification of the standard CC tables by map types or wind direction do not significantly improve the forecasting ability of the standard tables. This conclusion is contrary to what had been previously indicated by tests involving only dependent data.

Air Weather Service is currently concentrating its statistical prediction efforts on the model output statistics (MOS) approach to the objective forecasting of ceilings and visibilities (Bocchiere et al., 1972 and 1974). Results of the rigorous verification of the MOS models for forecasting ceilings and visibilities have been encouraging. Forecasts from MOS models have been shown to be an improvement over climatology and persistence forecasts. They even verified better than official subjective forecasts beyond the short range period. There are some disadvantages to the MOS approach, including the short period of data available for model development and the fact that the models become obsolete with the introduction of new or improved numerical weather prediction models.

One advantage that the map-type approach has over regression models such as MOS is that the verification results can be stratified by the relevant synoptic weather situation. The map-type forecast can then be shown to give relatively better or worse results under

different synoptic situations. The Colorado Springs verification did not consider this aspect nor was there any attempt made to improve the verification results by further stratification of ceiling and visibility data. Further research and a more detailed verification is required to assess the usefulness of map-type climatology in the development of automated forecast aids.

The Map-Typing Project Office in Colorado Springs is currently in the process of dissolution because of the disappointing verification results and the current USAF involvement with MOS techniques. The possibility exists that the map-type catalogues will not be used for their intended purpose of providing a regional synoptic history of surface pressure patterns which, when related to aviation weather parameters, could be a useful aid to the aviation forecaster.

1.4 Purpose

It is the intent of this thesis to apply the basic map-type techniques developed in Colorado Springs to the development of a surface map-type catalogue for the Mackenzie River Valley for the three coldest winter months. Included in the catalogue are statistics on the frequency of occurrence of map types, sequences of types and a listing of the map types occurring on each day of the 27-year period.

Yellowknife hourly weather observations at map time and at three hours before and after map time are examined to show the relationship between significant weather parameters and the map types near the time of their occurrence. Percent probabilities of occurrence

of the parameters are determined for sixteen years of dependent data. These probabilities are used to predict the occurrence of ceiling and visibility categories and the results are verified using four years of independent data.

Hourly observations at three-hour intervals from six hours before a map-type occurrence to twenty-four hours after its occurrence are used in the verification procedure. In addition to comparing verification results at different hours, a comparison is made between verification results for 00Z, 12Z and combined 00Z and 12Z maps. The final step in the verification procedure is an analysis of the results of forecasts based on map types that have been stratified according to pressure gradients. The purpose of these comparisons is to determine the best way to proceed in the development of an automated objective forecast aid. The improvement of map-type forecasts over pure climatological forecasts is carefully documented in order to assess the usefulness of this objective forecast technique.

CHAPTER II

THE BASIC DATA

2.1 Geographical Area

The difficulty in accurately forecasting weather for aviation terminals in the Mackenzie River Valley was appreciated during a forecasting assignment at the Arctic Weather Centre (AWC) in the summer of 1974. The sparseness of observational data and the formidable mountain ranges west of the valley are factors which challenge a forecaster's ability. A well-tested and readily accessible climatological synoptic forecast aid could be of considerable benefit to the forecasters at the AWC.

The area or window used in the map-typing procedure is shown on Figure 2 which is located in Appendix I. The window includes the 20 grid points which are numbered in the figure. Its size conforms with the criteria used by the Map-Typing Project Office to delineate the fourteen CONUS windows (Nieman and Sabin, 1972). It is large enough to enclose typical synoptic systems but not so large that small synoptic features might be ignored in the correlation of the overall pressure pattern. Printed on Figure 2 are the location

identifiers of those terminals for which 12-hour Terminal forecasts (FT's) are routinely prepared by the Atmospheric Environment Service (AES). Yellowknife (YZF) has the most extensive and complete set of hourly weather records in the Northwest Territories and for this reason was chosen as the principal site to be used in this study.

2.2 Surface Data

A 26-year data base (1946-1971) of mean sea level (MSL) pressures located at grid points on a standard 381 km grid was acquired from the Map-Typing Project Office in Colorado Springs. The data, arranged by month, are stored on two magnetic tapes. Pressures are available for 306 grid points on an 18 x 17 grid network which encompasses all of Canada, including the Arctic Islands and the Beaufort Sea. December, January and February pressure values at the twenty Mackenzie-window grid points were extracted from the two master tapes and stored on one smaller tape. MSL 12Z pressures are available for every year and 00Z values are available for the years 1956-1960 and 1963-1971. There is an exception in the case of December which has 00Z pressure values for the years 1955-1959 and 1962-1971. Consideration was given to incorporating upper-level patterns into the scheme by developing a catalogue of 500-1000 mb thickness patterns. Unfortunately, a comparable set of 500 mb height data was not readily available.

Twenty years (1953-1972) of continuous hourly weather observations for Yellowknife were obtained from the AES. The data are chronologically ordered and stored on magnetic tape in the

standard AES card 1 type format. Data for November 30, all of December, January, February and March 1 were extracted from this tape and stored on a separate tape.

To maximize the use of the twenty years of observations, 1972 grid-point pressure values for the three coldest months were extracted by hand from 00Z and 12Z surface analyses stored at the AWC. These maps were also used to acquire pressure data for missing and incorrect data in the 26-year data base. A date check of the pressure data base had uncovered several errors and duplications which had to be corrected.

2.3 Aviation Weather Parameters

The selection of ceiling and visibility categories was based on a discussion with the Officer-in-Charge of the AWC, and on the classification that is used in hourly data summaries (Climatology Division, 1958). The categories are defined in Table 1.

Table 1

Significant categories of ceilings and visibilities

Category	Ceiling (feet)	Visibility (miles)
A	0 - 400	0 - 3/4
B	500 - 900	1 - 2 1/2
C	1000 - 4500	3 - 5
D	$\geq$ 5000	$\geq$ 6

Categories A and B are below, and C and D are above the standard Visual Flight Rules (VFR) limits of 1000-foot ceiling and three-mile visibility. The 5000-foot ceiling and six-mile visibility limits are used in the international TAFOR code to delineate conditions significant to aviation. The occurrence of any amount of precipitation in excess of a "trace" is considered significant. Ice crystals, blowing and drifting snow are not considered as precipitation in this context. Expected windspeeds less than or equal to 12 miles per hour need not be forecast on an FT, but winds greater than 12 miles per hour are considered significant.

Wind direction is not usually a critical aviation forecast parameter and is not as difficult to forecast as are the other parameters already mentioned. Wind direction is, however, very dependent on the pressure configuration. It was therefore decided to use five simple direction categories to verify the anticipated good relationship between wind direction and the map types. The categories are defined as follows:

N - north northwest to northeast

E - east northeast to southeast

S - south southeast to southwest

W - west southwest to northwest

0 - calm

It has been previously mentioned that the hourly data were stratified according to pressure gradient. Increased stratification is desirable in order to define more accurately the conditions associated with the significant weather parameters. Too much strat-

ification will reduce the number of cases available for calculating the probabilities of occurrence to such an extent that the resulting statistics would not be reliable. Having only four categories of ceiling and visibility, instead of five or six, will help alleviate this problem. The available data are further maximized by considering a three-month cold season instead of individual months.

2.4 The Cold Season

Winter is the longest season of the year in the Mackenzie Valley and the winter months have greater percentages of poor aviation weather than summer months. Ten years (1957-1966) of Yellowknife hourly data summaries (Climatology Division, 1968) of temperature, precipitation, visibility and ceiling categories were examined. It was determined that a relatively uniform cold season exists for the three months of December, January and February.

Figure 1 shows the monthly frequency of occurrence of weather below VFR conditions. The predominance of "bad" weather during the winter is the principal reason why a three-month cold season is used in the study. The reduced number of bad-weather cases during the warmer months could create statistical reliability problems for highly stratified data.

The figure does show significant differences in the monthly frequencies of bad weather in the winter. The frequencies are greater than 20 percent in the earlier part of the winter and drop to less than six percent in late winter. Much of this bad weather in October and November is probably due to the influence of Great Slave Lake

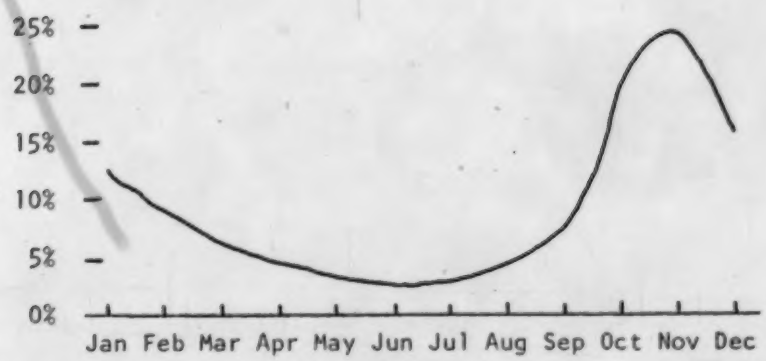

Figure 1. Average percent frequency of weather below VFR (ceiling 0-900 feet and/or visibility 0-2½ miles) based on ten years (1957-1966) of hourly observations at Yellowknife.

which does not freeze over until December (Allen and Cudbird, 1971). The three coldest months are therefore desirable for this study because relationships between map types and bad weather during this cold period are not so likely to be complicated by lake effects.

CHAPTER III

THE SURFACE MAP TYPES

3.1 Developing the Basic Types

The surface map types for the Mackenzie window were developed using the techniques of the Map-Typing Project Office in Colorado Springs. In particular, the batch technique of Sabin and Nieman (1972) and the computer programs of Wold (1973) were used to derive the Mackenzie catalogue. These methods, used extensively in the generation of the CONUS and Alberta map-type catalogues, are described in detail by Kociuba (1974) in Chapter III of his M.Sc. thesis.

One month's surface pressure data for the twenty grid points in the Mackenzie window were used to correlate all 12Z maps from 1954-1971 with each other. The formula for the product-moment linear correlation coefficient (r) for n pairs of values is:

$$r_{xy} = \frac{\sum_{i=1}^{n} \{X_i - \bar{X}\} \{Y_i - \bar{Y}\}}{\left\{ \sum_{i=1}^{n} [X_i - \bar{X}]^2 \sum_{i=1}^{n} [Y_i - \bar{Y}]^2 \right\}^{\frac{1}{2}}} \qquad (1)$$

The map that correlated with the largest number of maps in the 18-year sample at or above r = 0.8 was chosen as the key map for the first map type. That map and all others correlated with it were then removed from the sample. Of the remaining maps, the map which had the largest number of maps correlating with it became the key map for the second map type. This procedure of selection and removal was repeated until the number of maps assigned to a type became less than six. All the maps in the monthly sample were then reassigned to those particular types with which they correlated most highly at or above the threshold value of r = 0.8. Any map type having fewer than two percent of the total maps was eliminated as a map type. Those maps which did not correlate with any type at or above r = 0.8 were assigned to an uncorrelated group.

This process was repeated for each of the three coldest months. Table 2 shows the derived map types for each month, the number of maps assigned to each type initially, and the number after the reassignment procedure. The map types are listed in the order in which they were initially developed. This results in a decrease in the number of maps correlated with each type because maps correlated with a given type were eliminated from the sample as the procedure progressed.

Sabin (1974) justifies the use of the threshold value r = 0.8 by showing that it is a good compromise value. It results in a good overall description of pressure regimes, produces an acceptable number of uncorrelated maps, and gives an adequate description of the climatology within each type.

Table 2

Key dates of monthly and seasonal[1] map types with the number of maps before/after reassignment in the development sample (12Z maps, 1954-1971).

	DECEMBER		JANUARY		FEBRUARY	
Number of Types	Map Type Date	Number in each Type	Map Type Date	Number in each Type	Map Type Date	Number in each Type
1	621213	62/38	570122	90/62	650207	57/44
2	621227	53/38	690139	50/34	640217	49/37
3	591222	46/35	560101	42/35	550225	41/35
4	621216	32/30	570124	38/30	640222	30/32
5	561211	31/17	610108	30/32	600202	25/31
6	681221	23/26	550111	28/26	600223	19/20
7	681223	18/20	650126	19/26	540211	17/17
8	561219	16/14	590128	15/26	690207	16/20
9	601203	13/17	540101	14/15	590206	12/13
10	621224	11/11	590131	11/21	610217	11/11
11	571230	11/23	710108	10/16	600210	10/11
12	661205	10/11	680105	10/11	560210	10/11
13	551209	10/14	550115	10/11	650211	9/10
14	671204	8/12	540102	9/11	580213	9/10
15	631221	8/20	610131	8/19	680207	8/9
16	621222	8/20	640120	7/10	570210	8/9
17	611219	8/11	600103	6/9	680219	6/6
18	601219	7/7	560117	6/7	630216	6/16
19	701203	6/7	550124	6/8	600216	6/7
20	591227	6/8	550113	6/6		
21	551215	6/13				
22	541227	6/7				
Uncorrelated		158		143		159
Total Maps		557		558		508

[1]The final seasonal map types are underlined.

As would be expected, the reassignment procedure reduced the number of maps assigned to the more numerous types and increased the number assigned to most of the less numerous types. There was little change in the order of predominance of the more numerous types, but there were substantial changes in the order of those types which were initially not very frequent. For example, Map Type 18 in February became the ninth most frequent type after reassignment, and Types 15 and 16 in December moved up to seventh in the order of frequency.

To obtain the cold-season types, all 61 monthly map types were correlated with each other using the correlation coefficient threshold of $r = 0.8$. The correlation procedure was the same as that used previously, except that there was no reassignment step, and those maps not eliminated in the initial assignment were designated as final seasonal map types. This procedure resulted in 24 cold-season map types, and the respective key dates for these types are underlined in Table 2. The key date of each map type and the corresponding grid-point pressure values are listed in Appendix 1.

3.2 Assigning Maps to Map Types

After the surface pressure data had been corrected and the data base expanded to include 1972 data, each of the 3814 00Z and 12Z maps were correlated with the 24 map types. The maps were assigned to the map type with which they correlated most highly at or above $r = 0.8$. If the maximum correlation coefficient between a given map and all of the types was less than the threshold value, then the map was

assigned to a group of maps designated as uncorrelated Map Type U. The common feature of these maps is their non-conformity with any of the 24 map types. For this reason they are treated as a distinct group of their own so that Map Type U becomes the 25th "map type".

Of all the maps assigned, 34 percent had a maximum correlation coefficient less than r = 0.8. This is a relatively high proportion of Map Type U, compared to the 20-30 percent of uncorrelated maps in the catalogues developed by the Map-Typing Project Office in Colorado Springs. The proportion of uncorrelated maps can easily be reduced by lowering the threshold correlation coefficient used in the assignment procedure. The use of threshold values of r = 0.75 and r = 0.70 resulted in the reduction of uncorrelated maps to 21 and 13 percent, respectively.

Lowering the threshold value of r reduces the average correlation coefficient of all maps assigned to a particular type, thereby "diluting" the distinctiveness of each set of map types. This will only be a problem in this study if the distinctiveness of the weather associated with each set of map types is also blurred. Verification tests were performed on the probability forecast model to assess the effects of using map-type data assigned at the threshold levels of r = 0.75 and r = 0.70. The uncorrelated maps were included as predictors during these tests. The verification results of these ceiling and visibility forecasts will be examined in Chapter VI.

No attempt was made to test the model using map types assigned at thresholds higher than r = 0.8 because of the undesirability of increasing the proportion of uncorrelated maps. Any such

increase would be at the expense of the maps assigned to the 24 correlated types. This reduction in numbers would result in a decrease in the reliability of the probability statistics derived from the 24 map-type predictors.

Increasing the data base by combining monthly data into a relatively uniform season was the most obvious way to increase the reliability of the probability statistics. Another way to increase the number of hourly observations associated with a given map type was to consider an additional type when a map is correlated above $r = 0.80$ with two maps and the difference between the correlation coefficients is small. In such cases the hourly data are associated with both types. It was arbitrarily decided by the Map-Typing Project Office to follow this procedure when the second-highest correlation coefficient was within 0.05 of the highest correlation coefficient. This procedure was followed in this study. The effects of using map-type predictors based on this artificially expanded data base are assessed in Chapter VI.

The complete results of the map-type assignment procedure are listed in Appendix 2. The dates of each map are listed in chronological order, followed on the same line by the highest correlation coefficient and associated map type resulting from the correlation between the map and the 24 map types. An "S", "M" or "W" attached to the map type designator classifies the average pressure gradient of the map as being strong, medium or weak, respectively. Listed next, and on the same line, is the second-highest correlation coefficient. It is followed by the associated map type if $r \geq 0.8$. When the second map type is listed and the difference between the

highest and second highest correlation coefficient is less than or equal to 0.05, the second map type is marked with an asterisk (*). If the map is of Type U, a group of asterisks takes the place of the second highest correlation coefficient, followed by the map type with which Type U correlates most highly. This pertinent feature regarding uncorrelated maps was unfortunately omitted from the map-type catalogues developed by the Map-Typing Project Office.

CHAPTER IV

MAP-TYPE CHARACTERISTICS

4.1 Map-Type Occurrence Statistics

The individual occurrence statistics for each map type, including the uncorrelated maps, are given in Appendix 3. At the top of each page is an actual, dated surface weather map showing the isobaric configuration of the key map. All of the maps in each type correlate most highly with the key map, and the correlation coefficient is greater than or equal to $r = 0.8$. Beneath the key map are the characteristics of the map type, stratified by season and by month. The seasonal statistics were derived from 3700 maps of synoptic patterns observed in 26 cold seasons, from the winter of 1946-47 to the winter of 1971-72. The monthly statistics for January and February 1946, and for December 1972 are not included in the seasonal characteristics, but are included in the monthly characteristics. The correlated map types in Appendix 3 are numbered and listed in the order of their frequency of occurrence during the cold season. The uncorrelated maps of Map Type U have their characteristics listed on the last page of the appendix. The predominance of un-

correlated maps is consistent through each month of the cold season, with the highest percentage (36 percent) occurring during December. The frequencies of occurrence of the predominant correlated types will now be discussed.

Map Type 1 is the predominant type throughout the cold season, with a frequency maximum of 13 percent in January. This compares with seven percent in December and eight percent in February. Since January is the coldest winter month, it is not surprising that the most frequent map type is one which features a cold Arctic high-pressure ridge paralleling the Mackenzie River Valley from the Beaufort Sea into northeastern Alberta.

A low-pressure system located in the Gulf of Alaska is a very common synoptic situation during the winter months. When this low is well developed and located in the northeastern part of the Gulf, the Mackenzie Valley Arctic ridge is often forced eastward into the District of Keewatin. This synoptic development results in a southeasterly pressure gradient over the Mackenzie Valley, the Yukon and eastern Alaska. Map Type 2 has this isobaric configuration. It occurs consistently about seven percent of the time throughout the cold season. In December and February it slightly exceeds the frequency of Map Type 1.

Map Types 3 and 4 have nearly identical frequencies of occurrence throughout the cold season, and follow a monthly occurrence pattern similar to Map Type 1. They both have frequencies of five and three percent, respectively, in December and February, and maximum monthly occurrences of eight percent in January. Both map patterns are dominated by Arctic high-pressure centers, which may account for

their relatively high occurrence frequency in January. The high-pressure area in Type 3 is centered just southwest of Norman Wells while Type 4 has a high centered over the Yukon, just north of Whitehorse.

Map Type 5 has a trough of low pressure extending along the Arctic coast from a low-pressure system over Alaska. This configuration produces a southwesterly flow over most of the window, with a resultant influx of mild air south of the trough. As would be expected, this type is predominant in December, the mildest of the three cold months.

The five most frequent types account for nearly one-third of all the occurrences in the 26 winters. Despite the fact that the three months are well within the winter season, there are changes in the map pattern occurrences that are climatically consistent with the advance of the season.

4.2 Annual Variability in Map-Type Occurrences

Map types show considerable variation in frequency of occurrence from year to year, as can be seen by examining Table 3, which shows the maximum annual anomalies of seasonal and monthly occurrences for all types. The absolute differences between the percent frequency for a given year, and the averages over all 27 years, were compared for each map type. Those types with the greatest absolute differences are listed in Table 3. This method of determining anomalies was chosen because it highlights the characteristics of the more frequently occurring types. Occasionally, though, a type

Table 3

Maximum annual anomalies of seasonal and monthly occurrences[1]

Year	Season	December	January	February
1946			6-16.1 (3.7)	6-17.8 (5.8)
46-47	10- 6.6 (2.3)	1-16.1 (7.1)	16- 9.7 (2.0)	10-10.7 (3.1)
47-48	U-40.0 (34.1)	2-29.0 (7.3)	U-54.8 (31.8	4-20.7 (2.9)
48-49	U-45.0 (34.1)	U-48.4 (35.6)	5-16.1 (4.2)	3-10.7 (3.2)
49-50	1-20.0 (9.3)	3-19.4 (4.7)	4-29.0 (7.5)	11-10.7 (1.9)
50-51	U-42.5 (34.1)	18- 9.7 (1.4)	6- 9.7 (3.7)	3-10.7 (3.2)
51-52	7-11.4 (4.2)	4-19.4 (5.2)	7-22.5 (4.3)	6-20.7 (5.8)
52-53	18-11.3 (1.4)	2-12.9 (7.3)	1-25.8 (12.8)	18-14.3 (1.8)
53-54	1-15.0 (9.3)	6-22.6 (5.2)	1-22.6 (12.8)	1-17.8 (7.7)
54-55	7-12.5 (4.2)	13-12.9 (1.6)	2-16.1 (5.5)	7-21.4 (5.6)
55-56	4-12.6 (5.1)	U-41.9 (35.6)	4-17.7 (7.5)	U-43.1 (34.8)
56-57	U-26.4 (34.1)	3-13.1 (4.7)	3-23.0 (7.8)	1-21.4 (7.7)
57-58	2-13.3 (6.8)	6-19.4 (5.2)	2-17.7 (5.6)	7-16.1 (5.8)
58-59	1-23.3 (9.3)	1-19.4 (7.1)	1-37.1 (12.8)	U-46.4 (34.8)
59-60	1- 3.8 (9.3)	5-14.5 (6.3)	1- 6.5 (12.8)	6-15.5 (5.8)
60-61	8-10.0 (2.7)	20- 9.7 (0.8)	6-22.6 (3.7)	9-14.3 (3.2)
61-62	2-11.3 (6.8)	17- 9.7 (1.1)	7- 0.0 (4.3)	U-21.4 (34.8)
62-63	U-29.4 (34.1)	U-25.8 (35.6)	20- 7.9 (0.8)	10-12.5 (3.1)
63-64	U-40.7 (34.1)	8-16.1 (3.2)	U-41.9 (31.8)	7-13.8 (5.8)
64-65	3-12.7 (5.3)	U-48.4 (35.6)	U-22.6 (31.8)	3- 7.1 (3.2)
65-66	U-41.6 (34.1)	5-11.3 (6.3)	U-45.2 (31.8)	11- 7.1 (1.9)
66-67	1- 3.3 (9.3)	11-16.1 (3.2)	4-16.1 (7.5)	1- 1.8 (7.7)
67-68	U-41.2 (34.1)	15-11.3 (2.0)	U-55.8 (31.8)	7-10.3 (5.8)
68-69	5- 9.3 (5.1)	23- 8.1 (0.5)	3-16.1 (7.8)	2-21.4 (7.8)
69-70	2-11.1 (6.8)	8- 9.7 (3.2)	1-25.8 (12.8)	U-44.6 (34.8)
70-71	1-13.8 (9.3)	1- 1.6 (7.1)	1-27.4 (12.8)	6-14.3 (5.8)
71-72	4-13.2 (5.1)	2- 1.6 (7.3)	4-19.4 (7.5)	1-19.4 (7.5
1972		4-19.4 (5.2)		

[1]The format under each time period is as follows:
Map Type - Percent Frequency (Average Percent Frequency over all years).
Negative occurrence anomalies are underlined.

that has a low frequency will appear as the maximum anomaly. Map Type 18, for example, occurred with a frequency of 11.3 percent in the 1952-53 cold season, which is about eight times higher than its average frequency of 1.4 percent.

The two most frequent patterns, Type U and Type 1, are also the dominant anomalies: they both occurred 13 times as monthly anomalies. Moreover, on a seasonal basis, Type U appears as an anomaly eight times, and Type 1 six times. These two types predominate to an even greater extent those maximum anomalies that arise due to a frequency that is much lower than average. These negative-occurrence anomalies are underlined in Table 3.

The highest frequency anomaly appeared in January, 1968, when Type U occurred some 56 percent of the time. Of the correlated maps, Type 1 had the highest anomaly when it occurred with a frequency of some 37 percent in January, 1959. This was almost three times its average value of 13 percent and the difference from the average was the largest of any map type including Type U. Types 1 and U also had the highest seasonal anomalies for correlated and uncorrelated types; 23 percent in 1958-59 and 45 percent in 1948-49, respectively.

Map Type 23 had the maximum anomaly - the greatest increase relative to its average frequency - with an eight percent occurrence in December, 1968. This is 16 times higher than its monthly average of 0.5 percent. The most anomalous season was 1958-59 with summed absolute differences for the season and the individual months equalling 62.2 percent. In the least anomalous season, 1946-47, the sum of the differences equalled 28.6 percent.

The season with the greatest variety of map types was 1965-66, when all types except Type 24 occurred at least once. This season also had a very high frequency of uncorrelated maps (42 percent). This suggests that the 1965-66 season was characterized by frequent changes in the pressure patterns with a minimum of map-type persistence. Clearly the persistence of map types affects the variability of their occurrence frequencies; this relationship is examined in the next section.

4.3 Map-Type Persistence

The degree of persistence of individual map types can be determined by examining the *most frequent duration* characteristic, a quantity listed in Appendix 3. The term *persistence* is used to denote two or more consecutive occurrences of a map type which has been assigned at 12-hourly intervals, using a threshold correlation coefficient of $r = 0.8$. The persistence information is based only on 15 to 16 years of data when both 00Z and 12Z data were available. It should be noted that the frequency of consecutive occurrences is the percent frequency of groups (1, 2, 3 ... etc.) of occurrences, not the percentage of maps that fall within a group. This form conveniently gives the percent probability of consecutive occurrences after a given initial occurrence. This is useful prognostic information.

Over the entire season, Map Type 1 is the most persistent configuration, appearing as a group of two or more consecutive occurrences 53 percent of the time. Map Types 4, U, 2, 3, 5 and 6

are the next six most persistent types. It is no coincidence that these most persistent types are also among the most frequently occurring types. The good relationship between frequency and persistence is further substantiated by the fact that Map Types I and U share the longest run of 11 consecutive occurrences. However, this relationship is not exact and, in the case of less frequently occurring types, the correspondence is poor. Map Type 11, for example, is the 19th most persistent type, and Map Type 22 is the 15th most persistent type.

The persistence of all map types combined can best be examined by considering the percentage of maps that fall into a group of two or more consecutive occurrences. For those years when 00Z and 12Z data were available, some 65 percent of the maps appear in sequences of two or more consecutive map-type occurrences. The random probability of two consecutive occurrences is 14.6 percent compared with the actual frequency of 27.2 percent. Synoptic map patterns are, therefore, persistent features over the Mackenzie Valley during the coldest winter months.

Each of the seven most persistent types appears at least three times as a maximum anomaly, as shown in Table 3. Despite this good correspondence, not all occurrence anomalies are associated with a persistent map type. Thus, Type 18 is the least persistent, appearing as a single occurrence 90 percent of the time. In February, 1953, it occurred four times, all non-consecutively; this is the maximum anomaly for February. The non-persistency of Type 18, and its relationship to map-type sequences is discussed in the next section.

4.4 Sequences of Map Types

In Appendix 3, the types most frequently following each of a given map type are listed in order of their frequency of following occurrence. To glean information on a sequence of more than two 12-hourly occurrences, the following-type information on a particular, most frequently following type should be consulted.

Two features of the following-type data are prominent and generally consistent with previous remarks. Map Type U is the most frequently following type for 13 of the 25 seasonal map types. This appears reasonable in view of the very high frequency of occurrence of uncorrelated maps. Ten of the twelve remaining map types follow themselves most frequently. Included in these 10 types are the seven most persistent types mentioned in the previous section. This is entirely consistent with the conclusion that the surface map patterns are very persistent during the cold season.

A different explanation is required to account for the uncorrelated maps being relatively more predominant as a following type, than as an occurring type. In the light of the findings of the preceding paragraph, it can be concluded that only two map types evolve frequently into another correlated map type. Ninety-two percent of the types most frequently persist or are followed by an uncorrelated map. This general pattern of synoptic evolution is in agreement with Burns' (1970) climatic study of the Mackenzie Valley. He found that the cold dome of Arctic air that prevails over the valley during winter forms a block to the migrating frontal lows. This blocking action would seem to account for the high persistence of map types,

and the limited degree of map-type evolution.

The highest frequency of following occurrence is 60 percent when Type U follows Type 23. This map type follows itself 27 percent of the time and, therefore, only evolves into another correlated type 13 percent of the time. This behavior is not unexpected because the key map shows no closed pressure center, but only a broad trough extending north over Great Slave Lake, and northwest to the Mackenzie delta. This configuration also has one of the lowest average pressure gradients of all the correlated types.

The second-highest frequency of following occurrence (52 percent) is ascribed to Map Type 2, following Type 18. From the key map, this sequence shows a low-pressure center moving southeastward out of northeastern Alberta. A high-pressure center over Banks Island moves southward while an associated ridge builds in behind a migrating low. It is significant and appropriate that Type 18, the least persistent of all, also appears in the most frequent map-type sequence.

4.5 Mean Pressure Characteristics of Map Types

One of the most significant aspects of the correlation method of selecting map types is that the maps assigned to a type are only similar in respect to their isobaric configurations and direction of flow patterns. Scholefield (1973) showed that the correlation coefficient between two maps of identical configuration does not change when one of the maps is altered with respect to its pressure gradient or its overall pressure magnitude. This characteristic will

become evident during the analysis of gradients and mean pressures.

During the map-type assignment procedure, the average of the MSL pressure values at the 20 grid points was calculated for each map. After the maps were assigned, the mean values for each map within a type were averaged. These mean map-type pressures, minus 1000 mb, are listed with the map-type characteristics in Appendix 3.

Map Types 20, 23 and 24 have the highest mean pressure, all being very close to 1026 mb. A quick glance at the key maps shows Map Types 20 and 24 to be dominated by high-pressure centers and ridges. The reason for the high mean pressure is not obvious in the Type 23 key map, where a low pressure trough appears to be the major feature. Type 23 is a good example of how much the magnitude and gradient of isobars within the member of a type can vary. The key map has the lowest mean pressure (1010.4 mb) of all the maps of Type 23. Its pressure gradient of 3.06 mb/grid interval is also well below the type average of 4.04. These values are in sharp contrast to the monthly mean average pressure of 1032.8 mb and mean pressure gradient of 4.29 mb/grid interval of the six Type 23 maps of December. The key map does show a weak high-pressure ridge extending from the Yukon into the southern Mackenzie Valley. The intensity of this ridge must be very marked in the December maps.

Map Types 3, 1 and 4 have previously been mentioned as types that are dominated by Arctic high-pressure systems. These types along with Map Type 8 are in the next-highest group of mean pressures in the range 1024-1025 mb. They all have monthly maximum pressures in January, a consequence of the intensity of the Arctic high pressure

systems in this coldest month. This expected relationship is not obvious in the group with the highest mean pressures, but their low frequencies of occurrence make the monthly statistics unreliable.

Map Type 12 has the lowest mean pressure of 1011.7 mb. The range in average pressures of maps of this type is greater than for Type 23. Thus the Type 12 map of January 22, 1960 has an average pressure of 1033 mb, while the map of January 1, 1948 has an average pressure of only 990.1 mb.

4.6 Pressure Gradients of Map Types

Over relatively uniform topography, the strength of the low-level winds is proportional to the surface pressure gradient. The gradient is also a good indicator of the intensity of nearby pressure systems. Both wind speed and pressure-system intensity are important weather elements, but the correlation procedure does not resolve such features. This is the principal weakness of this map-typing technique. To alleviate this problem it was decided to investigate the pressure gradient characteristics of map types subjectively by attempting to subdivide the maps assigned to each type according to their pressure gradients.

The absolute value of the pressure gradient can be easily calculated from grid-point pressure values using the following five-point grid formula:

$$\text{Gradient } (X_5) = 0.5\,[(X_1 - X_3)^2 + (X_2 - X_4)^2]^{\frac{1}{2}} \text{ mb/gi}$$

where X_1, X_3 and X_2, X_4 refer to adjacent pairs of grid points

surrounding grid point X_5.

The gradient about a grid point may vary considerably from point to point throughout the window. A specific gradient value was assigned to a map by averaging the absolute values of the gradients at all eight interior grid points. As part of the assignment process, the standard deviations of the grid-point pressures and the differences between maximum and minimum values were also calculated as indicators of gradient. The mean of the absolute gradient about the eight interior grid points was chosen to define map pressure-gradients because it was more comprehensive than the other indicators. The values are expressed in logical gradient units of mb/grid interval (gi) and the values may be evaluated at any one of the eight locations within the window.

It was arbitrarily decided to subdivide the map type into three classes based on the standard deviation (s.d.) of the mean gradients of all maps within a type. The mean gradients that are within one s.d. of the total map-type mean are classified as "medium". The gradients that are more than one standard deviation below the mean are classified as "weak" and those more than one s.d. above the mean "strong". The critical value of the standard deviation for each map type is listed in Appendix 1 along with the grid-point pressures for the key maps.

Appendix 3 contains the mean gradient characteristics of each type in units of mb/gi. The mean maximum and minimum gradients were calculated by taking the average of the highest and lowest values, respectively, that occurred at the eight central grid points on each map.

A singular feature of the mean gradient statistics is the generally weak gradients associated with uncorrelated maps. The mean pressure gradient of Type U maps is only 4.04 mb/gi which is the lowest. Map Type 23 also has a low value of 4.04 mb/gi, but this statistic is questionable because there were only 17 occurrences of this type. The mean minimum and maximum gradients of 1.57 and 7.03 mg/gi for Map Type U are also very low. The lowest mean gradient for any map is found on the 12Z uncorrelated map of January 17, 1961 with a value of only 0.65 mb/gi. The weak gradient characteristic of uncorrelated maps is a good reason for grouping them into a separate Map Type U.

The similarity in characteristics of Types 3 and 4 shows up also in their maximum mean gradients of 6.61 and 6.07 mb/gi, respectively. They also have the highest mean maximum gradients. The Type 4 map of 00Z, January 16, 1957 has the highest individual mean-map gradient of 15.03 mb/gi. The highest gradient present at one grid point was 22.64 mb/gi on the Type 1 map of January 15, 1957. Individual grid-point gradients of 0.0 mb/gi are also found on occasion.

The differences in gradients between map types are apparent, but they are small compared to some of the differences between the gradients within the same type. The difference between mean gradients of the relatively strong gradient Type 3 and weak gradient Type U is only 2.57 mb/gi. There are a couple of individual maps of Type 3 with gradients less than 3.0 mb/gi and several uncorrelated maps with mean gradients in excess of 10 mb/gi. These large in-type gradient differences illustrate the inability of the correlation technique to

discriminate between gradients. For this reason the map types will be stratified by gradients when testing a simple probability model relating ceilings and visibilities to map types.

CHAPTER V

RELATING YELLOWKNIFE WEATHER TO MAP TYPES

5.1 Climatic Averages and Anomalies

The characteristic climatic feature of the Yellowknife winter is the cold weather which, as noted in Chapter IV, is related to Arctic high-pressure systems. In the climatic data there is good evidence of a quantitative relationship between low temperature regimes and the occurrence of certain map types. In 1949-50, the coldest of the 26 seasons, the mean daily temperature was -23°F. As shown in Table 3, Type 1 has the maximum seasonal anomaly, while Types 3 and 4 have maximum monthly anomalies of occurrence during this coldest season. Types 1, 3 and 4 also appear as anomalies in the next four coldest seasons, in 1946-47, 1948-49, 1951-52 and 1955-56.

It is interesting that the five coldest winters occurred in the earlier part of the 26-year data period. The five-year moving averages, calculated for the entire period, show a pronounced warming trend through the 1950's. There was no obvious corresponding trend in map-type occurrences. However, the negative-occurrence anomaly of Type 1 in the 1959-60 season is significant, because it was the

warmest season, with a mean temperature of -0.9°F.

The moving averages showed no well-defined temperature trend through the 1960's, but a cooling trend developed during the last three winters of the decade. The winter of 1971-72 was one of the coldest since 1955-56, with the mean temperature dropping to -12.8°F. Associated with this cold season were maximum occurrence anomalies of Types 1 and 4.

The maximum precipitation recorded at Yellowknife during any season was 3.15 inches in 1960-61, with one-half falling in January, 1961. Referring again to Table 3, it is seen that Type 6 was the maximum occurrence anomaly during this snowy month, present some 23 percent of the time. The key map for Type 6 shows a low pressure system in northwestern Saskatchewan with an easterly circulation over Great Slave Lake, a favorable synoptic situation for precipitation.

Precipitation was recorded on 51 days of the 1957-58 season, the highest number of precipitation days in any of the seasons. A total of 2.82 inches of precipitation fell during this period, the second highest seasonal amount. Type 6 again appears in Table 3 as a maximum occurrence anomaly of 19 percent in December, when 1.27 inches of precipitation fell. Type 2 is the maximum anomaly for the month of January and the entire season. The key map for Type 2 shows the Arctic high east of Great Slave Lake, with a southeasterly flow over most of the window. A well-developed Gulf-of-Alaska low is the dominant feature outside the window. This synoptic situation favors the advection of moist, relatively mild Pacific air into the Mackenzie Valley, overrunning the dome of cold Arctic air and producing cloud

and precipitation.

Based on average conditions these pronounced anomalies indicate a fairly direct relationship between some of the map types and the weather at Yellowknife. To investigate this relationship in more depth, the hourly weather observations pertinent to each map type were examined in detail. The results of this study follow in the next section.

5.2 Relating Yellowknife Hourly Weather to Map Types

The Yellowknife hourly weather observations from January, 1953 to December, 1968 were analyzed as follows: the occurrences of weather parameters at three hours prior to map time, at map time and at three hours after map time were summed. This gives a six-hour associated weather period, centered around the time of a map-occurrence. There is also no overlap in the observations associated with types assigned at 12-hourly intervals. These 16 seasons of hourly data form the dependent data sample from which a conditional probability forecast model was developed. The three-hour interval between observations corresponds to that used in the forecast model.

The calculated statistics were based on the total number of weather-parameter occurrences associated with each type. Each category of ceiling, visibility and wind direction is treated as a separate parameter. For each type, the frequency of a weather parameter was calculated relative to the same parameter occurrence associated with other types. These relative frequencies are very strongly dependent on the number of type occurrences. The frequency of parameter occurrence relative to the map type occurrence gives a

much better indication of the association between weather and map types. This frequency was calculated by dividing the number of hourly observations of a parameter by the total number of hours associated with the corresponding map type. Such a frequency can be interpreted as the conditional probability of the parameter occurring, given a map-type occurrence.

Table 4 lists the four best associations for 11 weather parameters. In the center of the table are the parameter descriptions, including the total number of parameter occurrences and climatic frequency over the 16-year period. Listed to the right are the number of hourly parameter occurrences, the frequencies relative to the parameter and those relative to the associated map type. The statistics describing each associated map type are listed on the left side of the Table. The statistics on each parameter are listed in the order of the degree of association with the related type, as measured by the frequency relative to the type.

5.3 Ceilings, Visibilities and Precipitation

Ceilings and visibilities below VFR limits, and precipitation are the most significant aviation weather parameters; they are also most difficult to forecast. Frequently these three "poor-weather" elements occur simultaneously with certain synoptic situations. Map Type 6 provides a good example: it shows a relatively high degree of association with all three elements. Indications of this "poor-weather" association with Type 6 appeared previously in section 5.1 during the analysis of climatic anomalies.

Table 4

Significant weather parameter - map-type associations, based on Yellowknife hourly weather observations at all map times and at three hours before and after, during 16 years, 1953-1968.

Map Type	Num	Freq[1]	Weather Parameter	Num	Wea. Freq[1]	Type Freq[1]
14	48	1.9	Low Ceilings	24	4.9	16.7
6	105	4.3	(<1000 ft)	45	9.2	14.3
11	51	2.1	Total Num = 488	17	3.5	11.1
5	130	5.3	Clim Freq = 6.6%	43	8.8	11.0
6	105	4.3	Low Visibilities	48	9.7	15.2
12	48	1.9	(<3 miles)	21	4.2	14.6
17	48	1.9	Total Num = 495	17	3.4	11.8
11	51	2.1	Clim Freq = 6.7%	17	3.4	11.1
19	33	1.3	Precipitation	65	2.4	65.7
6	105	4.3		193	7.2	61.3
15	46	1.9	Total Num = 2680	82	3.1	59.4
13	49	2.0	Clim Freq = 36.2%	84	3.1	57.1
24	8	0.3	High Ceilings	24	0.4	100.0
23	12	0.5	(≥5000 ft)	35	0.6	97.2
16	40	1.6	Total Num = 5570	113	2.0	94.2
10	54	2.2	Clim Freq = 75.3%	149	2.7	92.0
20	20	0.8	Good Visibilities	60	0.9	100.0
10	54	2.2	(≥6 mi)	160	2.5	98.8
24	8	0.3	Total Num = 6357	23	0.4	95.8
3	127	5.1	Clim Freq = 85.9%	351	5.5	92.1

continued ...

[1]Frequencies are given as percentages

Table 4 continued:

Map Type	Num	Freq[1]	Weather Parameter	Num	Wea. Freq[1]	Type Freq[1]
1	209	8.5	Wind > 12 MPH	279	18.8	44.5
11	51	2.1		64	4.3	42.4
12	48	1.9	Total Num = 1487	56	3.8	38.9
3	127	5.1	Clim Freq = 20.1%	134	9.0	35.2
19	33	1.3	North Winds	77	3.8	77.7
23	12	0.5	(NNW-NE)	25	1.2	69.4
13	49	2.0	Total Num = 2024	92	4.5	62.6
7	107	4.3	Clim Freq = 27.3%	184	9.1	57.3
11	51	2.1	East Winds	141	5.4	92.2
12	48	1.9	(ENE-SE)	123	4.7	85.4
2	169	6.9	Total Num = 2600	430	16.5	84.8
15	46	1.9	Clim Freq = 35.1%	116	4.6	84.1
5	130	5.3	South Winds	120	21.0	30.1
17	48	1.9	(SSE-SW)	37	6.5	25.7
4	111	4.5	Total Num = 571	81	14.2	24.3
14	48	1.9	Clim Freq = 7.7%	23	4.0	16.0
3	127	5.1	West Winds	321	17.2	84.3
10	57	2.3	(WSW-NW)	113	6.1	69.8
1	209	8.5	Total Num = 1866	384	20.6	61.2
20	20	0.8	Clim Freq = 25.2%	37	2.0	61.2
17	48	1.9	Calm Winds	16	4.7	11.1
8	67	2.7		18	5.3	9.4
16	40	1.6	Total Num = 340	10	2.9	8.3
4	111	4.5	Clim Freq = 4.6%	24	7.1	7.2

Low visibilities and ceilings seem to be related in the synoptic situations of Type 11, because both elements occur together some 11 percent of the time with Type 11 regimes. The key map for Type 11 has a weak trough extending into the southern Mackenzie Valley from a low-pressure center just north of Banks Island. The resulting southeasterly flow over Yellowknife is conducive to the development of low ceilings and visibilities. The key map of Type 14 also shows a southeasterly flow over Yellowknife. In this case the trough runs along the 60th parallel from an Alaskan Gulf Low. Type 14 regimes produce low ceilings 16.7 percent of the time, which is the highest frequency of low ceilings associated with any type (see Table 4).

Despite the association between the "poor-weather" elements, the precipitation frequencies are much greater than the low-ceiling and visibility frequencies. This suggests that much of the precipitation falls from higher clouds or the intensity is low. This precipitation characteristic can be attributed to the predominance of the Arctic air which is usually very dry. Influxes of milder, moist air into the region are forced to rise over the cold Arctic dome, forming clouds above the Arctic inversion. Some of the precipitation that is released from these clouds may never reach the ground due to sublimation in the dry Arctic air.

Fresh southward surges of Arctic air through the Mackenzie Valley and into Alberta are often accompanied by extensive areas of cloud and light snow, especially north of the Arctic Front. The Type 19 key map is a good example of this synoptic situation. Some 66 percent of the observations associated with Type 19 reported

precipitation. Types 13 and 15 are two other precipitation types listed in Table 4. Their key maps show a similar easterly circulation pattern over Great Slave Lake. Air-mass convergence and overrunning of moist air from low-pressure systems in northern Alberta account for the high association of precipitation with regimes of Types 13 and 15.

The predominance of "good weather" at Yellowknife during the cold season is clearly indicated by the high climatic frequencies of 75.3 and 85.9 percent, respectively, for high ceilings and good visibilities. Some of the map types whose key maps are dominated by high pressure systems have considerably higher frequencies of good weather associated with them. Table 4 shows that both Map Types 24 and 20 have 100 percent of their associated observations in the highest ceiling and visibility categories, respectively. The other types listed are associated with high-category observations in excess of 90 percent of the time. Map types are, therefore, much better discriminators of "good weather" than "poor weather".

5.4 Winds

Strong winds are a significant aviation weather parameter. Table 4 shows that wind speeds greater than 12 miles per hour occur less frequently than precipitation, but more frequently than low ceilings and visibilities. As is the case for all parameters listed in the table, the frequency of the parameter associated with given map types is considerably greater than the climatic frequency. The most significant feature of this section of the table is the presence

of Types 1 and 3. Their association with strong winds is undoubtedly related to their previously described strong pressure gradients. The converse relationship between weak gradient map types and calm winds is not pronounced.

All maps belonging to a given type have very similar flow patterns. This is clearly illustrated by the high degree of association between map type and wind direction. Table 4 shows that 92 percent of the observations grouped with Type 11 have easterly winds. The other wind directions also exhibit high degrees of association with specific map types, with the possible exception of south winds which have a low climatic frequency of only 7.7 percent.

The absence of Type U from Table 4 shows that there are no weather parameters that are highly associated with uncorrelated maps. Most of the associations in Table 4 show the parameter frequencies of occurrence with map types to be greater than twice the climatic frequencies of these parameters. This suggests close relationships between map types and synoptic weather. The next chapter will examine the possibilities of using these relationships to predict weather in an independent data sample.

CHAPTER VI

PREDICTING CEILINGS AND VISIBILITIES AT YELLOWKNIFE BASED ON MAP TYPES

6.1 Developing the Probability Forecast Model

The computer program that determined the association of weather parameters with map types also calculated and stored for future use the probabilities of occurrence of the associated parameters over the 16-year dependent data period. These conditional probabilities were determined for 11 separate times associated with each map-type occurrence. The times were at three-hourly intervals; from six hours prior to map time up to 24 hours after a map type occurrence. Separate calculations were made for those observations associated with 00Z maps, 12Z maps and combined 00Z and 12Z maps. Climatic probabilities were also calculated using the identical procedure. For all climatic calculations, the hourly data were stratified only according to the hour of the map occurrence and the associated times before and after map time.

The basic statistical characteristics of the dependent data base are depicted in Table 5. They pertain to the 2467 hourly observations made at map time. An identical number of observations

Table 5

Number of occurrences and climatic probabilities of ceiling and visibility categories at 00Z and 12Z for the months of January, February and December 1953-1968.

Category	00Z		12Z		00Z + 12Z	
	Num	% Prob	Num	% Prob	Num	% Prob
Ceiling A	11	1.1	48	3.3	59	2.4
Ceiling B	41	4.0	55	3.8	96	3.9
Ceiling C	185	18.1	277	19.2	462	18.7
Ceiling D	786	76.8	1064	73.7	1850	75.0
Total	1023	100.0	1444	100.0	2467	100.0
Visibility A	17	1.7	29	2.0	46	1.9
Visibility B	56	5.5	62	4.3	118	4.8
Visibility C	70	6.8	123	8.5	193	7.8
Visibility D	880	86.0	1230	85.2	2110	85.5
Total	1023	100.0	1444	100.0	2467	100.0

are used to calculate probabilities at each of the other ten times associated with map types. The gaps in the 00Z map-type data result in there being fewer observations associated with 00Z.

Slight diurnal influences on the ceilings and visibilities can be detected by examining their probabilities of occurrence. Observations at 12Z have a greater percentage of the "poor" weather in category A than do the 00Z maps. Good weather in category D, on the other hand, occurs more frequently associated with 00Z maps. The infrequent occurrences of category A are the principal reason why no additional category or monthly stratification was introduced into the model. Because of the significance of this weather category to

aviation, it is desirable to have the related statistics as stable as possible.

6.2 Testing the Forecast Model

Once the probability statistics were calculated for all types, the results were used to forecast ceiling and visibilities according to the prevailing map type. Four years (1969-1972) of map-type data and Yellowknife hourly weather were used as the independent data sample to test the forecast model.

The main difficulty in verifying probability forecasts by using standard contingency methods is converting the probability forecasts to a categorical forecast. For example, it is difficult to determine which ceiling category will be forecast, given the probability forecasts for each of the four categories. One solution is to assign to each category a weight in proportion to the relative significance of accurately forecasting the category. Each categorical probability forecast is multiplied by its respective weight, and that category with the highest weighted probability becomes the categorical forecast.

One verification method that indirectly incorporates a weighting scheme is the Brier P-score, specifically developed to verify probability forecasts. The weighting is accomplished by raising the score of a group of categorical forecasts whose probabilities are not distributed ideally into one categorical forecast of 100 percent and the remainder into zero percent. If this measurement of the resolution of a forecast was the only criterion used in determin-

ing the score, then efforts to improve scores would likely lead to probability forecasts being either too high (overforecasting) or too low (underforecasting). To account for these possibilities, a further penalty is added when the probability of the forecast category does not correspond to the frequency of the category's occurrence. When there is little difference between the forecast probabilities and the frequency of category occurrences, the forecast is said to be reliable.

The resolution and reliability components of the P-Score are not at all obvious in the original formula developed by Brier (1950). The P-score formula is thoroughly analyzed in Appendix 4, where it is transformed into a formula which can be used to verify individual category forecasts, rather than a complete group of categorical forecasts. The transformed Brier Score formula for N forecasts of an event or category is[1]

$$B = \frac{1}{N} \sum_{k=1}^{n} M_k \left[(f_k - \phi_k)^2 + \phi_k (1 - \phi_k) \right] , \qquad (2)$$

where k refers to one of n probability classes and f_k is the probability that represents each class. In this study, 11 classes cover the full range of probabilities. Representing the lowest class of probabilities, from 0-4 percent, is $f_1 = 0.0$; the next highest class from 5-14 percent is represented by $f_2 = 0.10$ ... etc. and the highest range of probabilities, from 95-100 percent, is represented by $f_{11} = 1.00$.

The first term within the brackets of Equation (2) is the reliability term, while the second is the resolution term, and ϕ_k is

[1] See Appendix 4

the frequency of the event relative to the number of event forecasts. The maximum score of zero occurs when the event probability and relative frequency are both equal to zero percent or 100 percent. The worst score possible is B = 1.

A root-mean-square error in reliability can be defined from the reliability term in Equation (2) as

$$RMSE = \frac{100}{N} \sum_{k}^{n} M_k (f_k - \phi_k)^2 . \qquad (3)$$

The RMSE is used in this study to monitor the effect of reducing the number of event occurrences through increased stratification of the data. Good reliability results from having a suitably large number of events in a sample so that the probability statistics are stable.

Brier Score verification was also applied to the independent data forecasts that were made using the climatic probabilities. These climatology scores are compared with the scores calculated from the forecasts made using map-type-stratified conditional probabilities. If both scores were calculated on forecasts of the dependent data, then the map-type-stratified forecasts would always show an improvement over purely climatological forecasts. This will not necessarily be the case for map-type-stratified forecasts of independent data, for two reasons: first, there is no guarantee that the climatology of the independent data is going to be the same as the dependent data. Secondly, assuming that there is a relationship between map patterns and weather, certain map types will be better predictors than others, depending on the strength of the relationship. It is conceivable that a map type that is a relatively poor predictor will produce a

Brier Score that is worse than a climatology forecast score, when the forecasts are made on independent data.

It can be seen that the Brier Score is an ideal verification method for this study. It is specifically designed to verify probability forecasts, and gives a convenient measure of the forecast reliability as well as resolution. Moreover, the scores are calculated in such a manner that comparisons can readily be made with respect to different models, map types, weather elements and categories. One of the disadvantages of the method is that it gives no suitable measure of the effectiveness of a forecast that is to be used operationally. However, the concern of this thesis is to examine possible methods that could be used in the development of an operational model. When the model appears to be suitable for operational use, then some measure of its operational effectiveness should be determined.

6.3 The Verification Program

A computer program was developed for verifying four categorical forecasts at a time, using cold-season data for four years. The input data consisted of 660 maps at all 00Z and 12Z map times, 7986 hourly Yellowknife weather observations, climatic probabilities and conditional probabilities of the four category occurrences. The program progresses chronologically through the independent data, recording the number of times each category occurred and was forecast, the probability class in which the correct forecast was made, and for which of the 11 associated times the forecast was valid.

The results for each category were stored in a four-dimensional array, with each element of the array containing, in one computer word, the total number of forecasts and the number of correct forecasts. The four dimensions of the array correspond to the map time, the associated map-type time, the map type and the category. The Brier Scores were calculated from the storage arrays, and the results were listed in 33 tables. The tables are organized into three sets of 11 tables, for the 00Z, 12Z and combined map times, respectively. The tables in each set contain results for the 11 times associated with each map type.

Table 6 shows a typical verification table containing results for ceiling forecasts valid at map time for all 00Z and 12Z maps. The average results for each category were calculated by weighting each score according to the number of related map types. This is equivalent to weighting the scores according to the number of forecasts in each probability class as indicated in Equation (2), because each map-type score is based on only one probability class. For the purpose of comparison, the scores for climatology forecasts are listed immediately below the average scores.

Some characteristics of the scores given in this table require explanation. It has been stated that lower P-Scores indicate better forecasts. It would appear from Table 6 that the relatively rare category-A events are forecast more accurately than the more frequent category-D events. This can be explained by recalling that the best scores are given to those accurate category forecasts close to the limiting values of zero or 100 percent. All category-A probability forecasts score very close to zero, and since this

Table 6

An example of the verification results for one of 11 times associated with all map types and a summary of the set of 11 verification tables.

P-SCORES AND RELIABILITIES BASED ON ALL MAPS FOR CEILING FORECASTS AT MAP TIME + (0) HOURS

TYPE	CIG-A		CIG-B		CIG-C		CIG-D		AVERAGE	
	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)
4	0.089	0.24	0.0	0.0	0.088	0.00	0.095	1.19	0.058	0.36
8	0.063	0.11	0.0	0.0	0.0	0.0	0.107	0.79	0.042	0.23
1	0.0	0.0	0.0	0.0	0.221	2.66	0.157	0.00	0.094	0.67
3	0.0	0.0	0.0	0.0	0.031	0.54	0.031	0.54	0.016	0.27
6	0.0	0.0	0.111	1.23	0.268	2.09	0.250	0.08	0.157	0.85
7	0.0	0.0	0.0	0.0	0.313	6.48	0.210	0.00	0.131	1.62
2	0.096	0.92	0.056	0.18	0.038	0.43	0.229	0.23	0.105	0.44
17	0.0	0.0	0.0	0.0	0.0	0.0	0.010	1.00	0.003	0.25
14	0.0	0.0	0.110	0.06	0.010	1.00	0.190	0.25	0.077	0.33
9	0.0	0.0	0.0	0.0	0.0	0.0	0.040	4.00	0.010	1.00
13	0.0	0.0	0.0	0.0	0.223	0.11	0.227	0.44	0.112	0.14
5	0.111	1.23	0.112	0.08	0.036	0.46	0.214	0.82	0.119	0.65
11	0.067	0.44	0.133	1.78	0.250	12.76	0.235	0.06	0.171	3.76
18	0.167	2.78	0.0	0.0	0.090	9.00	0.227	0.44	0.121	3.06
23	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.00	0.000	0.00
21	0.0	0.0	0.0	0.0	0.040	4.00	0.160	16.00	0.050	5.00
19	0.0	0.0	0.0	0.0	0.390	20.25	0.390	20.25	0.155	10.12
10	0.0	0.0	0.0	0.0	0.143	2.04	0.010	1.00	0.038	0.76
20	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.00	0.000	0.00
12	0.083	0.69	0.010	1.00	0.235	0.06	0.260	1.00	0.147	0.69
20	0.0	0.0	0.0	0.0	0.010	1.00	0.040	4.00	0.013	1.25
16	0.0	0.0	0.0	0.0	0.125	1.56	0.110	0.06	0.059	0.41
15	0.0	0.0	0.0	0.0	0.360	36.00	0.250	0.69	0.152	9.17
22	0.0	0.0	0.0	0.0	0.0	0.0	0.250	25.00	0.063	6.25
0	0.033	0.11	0.019	0.04	0.122	0.41	0.203	0.03	0.054	0.15
AVRG	0.0329	0.23	0.0266	0.16	0.1308	2.13	0.1726	0.71	0.0906	0.81
CLIM	0.0348	0.12	0.0303	0.09	0.1364	0.14	0.1530	0.18	0.0986	0.14

PERCENT IMPROVEMENT OF MAP TYPE P-SCORES OVER CLIMATOLOGY P-SCORES
AT DIFFERENT TIMES BEFORE AND AFTER THE OCCURRENCE OF ALL MAPS

TIME	CIG-A		CIG-B		CIG-C		CIG-D		AVERAGE	
	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)	P-SCORE	RLBY(%)
	%DIFF	DIFF	%DIFF	DIFF	%DIFF	DIFF	%DIFF	DIFF	%DIFF	DIFF
-6	-20.54	-0.237	10.57	0.189	4.36	-1.200	2.57	-0.846	-0.76	-0.524
-3	-4.14	-0.161	10.08	-0.218	12.91	-0.490	4.22	-0.988	5.76	-0.464
0	6.98	-0.110	12.17	-0.065	4.07	-1.974	10.56	-0.531	8.45	-0.670
3	-12.96	-0.234	-11.15	-0.181	3.06	-1.745	9.42	-1.294	-2.91	-0.863
6	-20.80	-0.191	-45.56	-0.377	-2.78	-1.482	2.11	-0.943	-16.76	-0.748
9	9.91	-0.075	5.16	-0.444	10.26	-0.733	11.17	-1.363	9.12	-0.654
12	15.81	-0.050	-12.68	-0.257	9.19	-1.178	3.82	-0.887	5.03	-0.594
15	1.41	-0.091	3.24	-0.347	0.20	-1.777	15.44	-1.016	5.07	-0.808
18	3.40	-0.144	-13.21	-0.226	-3.19	-1.845	8.23	-1.017	-1.19	-0.808
21	12.00	-0.055	-0.21	-0.246	10.68	-0.306	5.86	-1.170	7.08	-0.444
24	7.76	-0.174	-16.12	-0.454	6.45	-1.291	6.45	-0.850	1.13	-0.692

FOR ALL MAPS, THE TOTAL AVERAGE MAP TYPE P-SCORE IS 0.0925 AND RELIABILITY IS 0.83 PERCENT
THE TOTAL AVERAGE CLIMATOLOGY P-SCORE IS 0.0970 AND RELIABILITY IS 0.17 PERCENT

category occurs very infrequently, it results in scores which are low.

When comparing scores between categories, it is more useful to consider the percent improvement of the map-type scores over the climatology scores as the measure of the forecast skill of the map-type forecast model. For example, the results in Table 6 show the map-type model as having greater skill in forecasting category D than category A, because the respective percent improvements over climatology are 10.6 and 7.0 percent.

It may also seem incongruous that category A, with the fewest occurrences, has a better reliability component than the most frequently occurring category D. Table 6 shows that the higher average reliabilities in the more frequently occurring categories are primarily due to a few very high-percent reliabilities present only with certain rather uncommon types - a factor which likely accounts for their poor reliability scores. For example, in the presence of Type 23, ceiling category C has a class frequency of 0.40, as determined from the dependent data. During the independent data period, Type 23 appeared 12 times, and each time the ceiling was in category C; this means its relative frequency in category C is 1.0. The square of the difference between the relative and forecast frequency results in a high reliability of 36 percent. The resolution component in this example is zero, so the P-Score is 0.36. The much lower number of category-A occurrences reduces the potential for high reliabilities, which explains why the average percent reliabilities are low.

Listed at the end of each set of tables is a summarization table giving the percent improvement over climatology of the category

forecasts of the 11 times associated with map types. An example of such a table is shown at the bottom of Table 6, a summary of the set from which the table above it was extracted. The bottom two lines give the overall scores and reliabilities for the set. The significance of these statistics is discussed in the next section.

6.4 Averaged Verification Results

Average verification scores were calculated over all four categories of ceilings and visibilities, and for all 11 times associated with all map types. The averages were calculated separately for forecasts based on 00Z, 12Z and combined 00Z and 12Z map times. These results, along with percent improvements over climatology, are listed in Table 7. In an attempt to improve the verification scores, the forecast model was modified in several ways. The averaged results of the modified versions of the basic model are also listed in Table 7.

The results for the basic model are listed first. The outstanding result is that map-type forecasts are a definite improvement over climatological forecasts of ceiling and visibility categories. There is, however, a significant difference in the forecast skills for ceiling and visibility forecasts. Based on all map times, the map-type ceiling forecasts are 5.03 percent better than climatology forecasts, whereas visibility forecasts are only 0.80 percent better. This discrepancy in forecast skill is understandable in view of the fact that the map-type patterns are synoptic features, and categories of cloud ceiling are more synoptic in nature than those of visibility. The best visibility forecasts are based on 00Z map times, which is

Table 7

Brier verification scores and reliabilities averaged over all weather categories, map types and 11 associated times (at three-hourly intervals) for map-type-stratified and climatology forecasts of independent data from 1969-1972.

Map Time	Weather Element	Map Type P-Score	Climat P-Score	Percent Better[4]	Reliability (%)[5] Map Type	Climat
00Z	ceilings	0.0908	0.0953	4.72	0.91	0.14
12Z	(r^1 = 0.80)	0.0944	0.0977	3.38	0.88	0.18
ALL		0.0925	0.0974	5.03	0.83	0.17
00Z	Visibilities	0.0972	0.0982	1.02	1.55	0.43
12Z	(r = 0.80)	0.1009	0.1017	0.79	1.54	0.58
ALL		0.0996	0.1004	0.80	1.42	0.46
00Z	Ceilings	0.0899	0.0953	5.67	0.88	0.14
12Z	(r = 0.75)	0.0945	0.0977	3.28	1.03	0.18
ALL		0.0915	0.0974	6.06	0.80	0.17
00Z	Visibilities	0.0978	0.0982	0.41	1.66	0.43
12Z	(r = 0.75)	0.1004	0.1017	1.28	1.62	0.58
ALL		0.0988	0.1004	1.59	1.48	0.46
00Z	Ceilings	0.0901	0.0953	5.46	0.86	0.14
12Z	(r = 0.70)	0.0953	0.0977	2.46	1.05	0.18
ALL		0.0916	0.0974	5.95	0.81	0.17
00Z	Visibilities	0.0976	0.0982	0.61	1.61	0.43
12Z	(r = 0.70)	0.1006	0.1017	1.08	1.58	0.58
ALL		0.0994	0.1004	1.00	1.43	0.46

continued...

Table 7, continued:

Map Time	Weather Element	Map Type P-Score	Climat P-Score	Percent Better	Reliability (%) Map Type	Reliability (%) Climat
00Z	Ceilings	0.0907	0.0953	4.83	0.90	0.14
12Z	(r = 0.80)	0.0944	0.0977	3.38	0.88	0.18
ALL	Expanded[2]	0.0925	0.0974	5.03	0.78	0.17
00Z	Visibilities	0.0969	0.0982	1.32	1.53	0.43
12Z	(r = 0.80)	0.1009	0.1017	0.79	1.54	0.58
ALL	Expanded	0.0985	0.1004	1.89	1.36	0.46
00Z	Ceilings	0.0967	0.0953	-1.47	2.21	0.14
12Z	(r = 0.80)	0.0967	0.0977	1.02	2.20	0.18
ALL	Gradient[3]	0.0966	0.0974	0.82	2.04	0.17
00Z	Visibilities	0.1020	0.0982	-3.87	2.73	0.43
12Z	(r = 0.80)	0.1043	0.1017	-2.56	2.96	0.58
ALL	Gradient	0.1017	0.1004	-1.29	2.49	0.49

[1]r - refers to the correlation coefficient used in the map type assignment procedure.

[2]Expanded - indicates that the dependent map type data base has been expanded to include maps that have their second highest correlation coefficient greater than or equal to r = 0.8, and within .05 of the highest r.

[3]Gradient - indicates that all 25 map types have been subdivided into three pressure gradient classes.

[4]Precipitation forecasts, based on surface map types over Alberta, were on the average 6.5 percent better than climatology for 23 stations (Kociuba, 1974).

[5]The average percent reliability for precipitation forecasts for 23 stations in the Alberta window was 1.08 percent (Kociuba, 1974).

indicative of a local diurnal factor rather than synoptic factor.

It was mentioned in Section 3.2 that when maps were assigned to types using a threshold correlation coefficient of r = 0.75 and r = 0.70, there was a successive reduction in the proportion of uncorrelated maps. These two additional map-type data sets were used in the forecast model in place of the basic set of map types which had been assigned at r = 0.80. The averaged verification results from this procedure are displayed in Table 7. Only in the case of visibility forecasts based on 00Z maps, and ceiling forecasts based on 12Z maps, are the results worse than those of the basic model. The forecasts based on all 00Z and 12Z map types of the r = 0.75 data have P-Scores better than the other models, for both visibilities and ceilings. For the latter, the improvement over climatology is 6.06 percent, or more than one percent greater than the basic model results, but only slightly better than the results of the model using maps assigned at r = 0.7.

The P-Score improvements were not so convincing as to warrant an immediate change in the correlation threshold used in assigning maps. There is enough evidence, however, to suggest further experimentation with other threshold levels using different years of independent hourly data at Yellowknife. To determine an optimum assignment threshold for the Mackenzie window, similar experiments to those just mentioned should be applied to other observing sites within the window.

The dependent hourly data associated with secondary map types were incorporated into the calculation of conditional probabilities. If a particular map was correlated with more than one map type

at or above r = 0.80, and the difference between the highest and second highest correlation coefficients was within 0.05, then that map was assigned to both types. In such a case the 11 associated hourly observations are used to represent the weather related to each type. The result of applying this process to the dependent data increased the total number of map-type cases from 2467 to 2792.

The probabilities determined from this "expanded" data base were used in the forecast model. The resulting verification scores for ceiling forecasts, shown on Table 7, are essentially unchanged from the scores of the basic model. The percent reliability for ceiling forecasts based on all map times, showed a slight drop from 0.83 to 0.78, but there was no change in the P-Score; this means that the resolution components of the forecasts are not as good as for the basic model. There is some improvement in the visibility forecasts based on all map times. The average reliability improved from 1.42 to 1.36 percent and the forecast skill increased from 0.80 to 1.89 percent, a significant improvement over climatology.

It was stated in Section 4.6 that all maps within the types were subdivided into three classes of strong, medium and weak gradients. The chronological listing of map types in Appendix 2 indicates the gradient class of each map. These gradient types were used in the forecast model. The verification results are the last two sets in Table 7. The P-Scores and reliabilities are clearly the worst in the Table, with reduced skill shown for ceiling forecasts, and negative skill for the visibility forecasts.

The probability statistics for the gradient types were based on the association of hourly weather with 75 types. Tripling the

number of types greatly reduces the number of observations associated with each type, resulting in a sharp increase in the percent reliabilities. For ceiling forecasts the reliabilities jumped above the two percent level, compared to less than one percent for the basic model.

The resolution components of the P-Scores were definitely lowered, but not enough to compensate for the poor reliabilities. Consider, for example, the ceiling forecasts based on all map times. Verification of the basic model forecasts produced an average P-Score of 0.0925, the sum of a reliability component of 0.0083, and a resolution component of 0.0842. For the gradient-type forecasts the resolution component was lowered to 0.0762, but the reliability increased to 0.0204, yielding a worse P-Score of 0.0966.

The importance of reliable statistics in the development of a successful forecast model was aptly demonstrated when using pressure gradients for further stratification of the data. Two additional conclusions can be derived from the reliability statistics in Table 7. First, the percent reliabilities for visibility forecasts are consistently worse than those for ceiling forecasts. This indicates greater local variability in the occurrences of visibility related to map types. Secondly, the reliability of forecasts based on combined 00Z and 12Z map times is better than the reliability based on the individual times. This can be directly attributed to the increased number of maps in the combined map-times data sample. The improved reliabilities are one reason why the skill of ceiling forecasts based on all map times is greater than of forecasts based on the individual map times. From the Table 7 results

it may be generally stated that better reliabilities and improved P-Scores result from enlarging the stratified data bases.

6.5 Significant Results from the Detailed Verification Scores

The verification program produced a total of six summary tables, identical in format to the one shown with Table 6: one table for each of the three groups of visibility and ceiling forecasts based on the 00Z, 12Z and combined 00Z and 12Z map times. An analysis of all these tables showed no apparent trend in the skill of the forecasts for the 11 times associated with the types. However, for the three summary tables of the basic-model ceiling forecasts, the skill at map time was always greater than the skill 24 hours after map time. The relationship for visibility forecasts was not quite as good. Similar comparisons were made between the skill scores for forecast pairs at -3 and +21 hours, and at -6 and +18 hours relative to map time. For 12 of the 18 pairs in all six tables, the forecast skill was greater at the hour nearest to map time. This indicates that forecasts near map time are more skillful than forecasts 24 hours later.

A result that stands out clearly on all summary tables of the basic model verification is the fact that map-type forecasts show less skill than climatology in forecasting weather in the two below-VFR categories. For example, the ceiling forecasts of the low categories based on all map times were, on the average, 2.5 percent worse than climatology forecasts, and the visibility forecasts were 4.1 percent worse. In contrast to these results, the map-type forecasts

of the two highest categories of ceilings and visibilities were 6.1 and 0.8 percent better than climatology.

The types that showed the best relationship between low ceiling and visibility categories in the dependent data set are given in Table 4. For each of these types, the frequency of the associated low category weather was significantly greater than the climatic frequency. If this had held true in the independent data sample, the P-Scores for these types would have been lower than the climatology P-Scores. As it turned out, the frequencies of the low categories for a majority of the associated times in the independent data were closer to the climatic frequency of the dependent data, resulting in the P-Scores for climatology forecasts being better for these types than the map-type forecasts. This agrees well with the results given in the previous paragraph.

Map Type 10 was a "good" weather type in the dependent data sample, as shown in Table 4, with 92 percent of the associated ceilings and 99 percent of the visibilities in the highest weather category. This compares with 75.3 and 85.9 percent, respectively, for climatology. During the independent data period, Type 10 occurred 15 times. The P-Score for category-D ceiling forecasts related to this type is 0.0497, a score averaged over the 11 associated times, and based on forecasts at all map times. This is 73.3 percent better than the 0.1859 average P-Score for climatology forecasts. The comparable visibility forecasts have verification P-Scores of 0.0529 vs. 0.1918 for a 72.4 percent improvement over climatology forecasts.

The forecasts related to the other "good" weather types, with the notable exception of Type 24, also produce considerably better P-Scores than the climatological forecasts. Table 4 shows that during eight occurrences of Type 24 in the dependent data sample, 100 percent of the ceilings and 95.8 percent of the visibilities associated with the type are in category D. This type appeared only three times in the independent sample. During the same six-hour associated-weather period, all nine observations were in category D, which means that the P-Score for this period was a perfect zero. The forecasts at the remaining eight associated times were, however, far from perfect, giving an average verification score of only 0.2715. This was -47.6 percent worse than the average climatology P-Score for the same period. As might be expected, poor reliability was one reason for the high scores. The average reliability over the eight hours is 10.5 percent, compared with only 0.39 for climatology.

As an individual map type, the uncorrelated group of maps exhibits some interesting verification results. The averaged P-Scores for the basic model forecasts related to Type U are better than climatology for both low weather categories and the highest category. The largest improvements over climatology are for the low categories: visibility forecasts improved 6.3 percent, and ceiling forecasts 5.8 percent.

When the number of maps in Type U were lowered by assigning maps at $r = 0.70$, the skill with which Type U forecast category D was enhanced, the ability to forecast the two lowest categories was reduced, but still slightly better than climatology forecasts. More significantly, the P-Scores related to the four types best associated

with the low categories improved, and the scores related to the types best associated with highest weather category worsened. Since these results apply to both ceiling and visibilities, they are significant. This suggests that the maps removed from the uncorrelated group when the assignment threshold was lowered to r = 0.70 had appreciable amounts of below-VFR weather associated with them.

CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 The Surface Map-Type Catalogue

A catalogue of surface map-type patterns over the Mackenzie Valley has been developed using the computerized procedures of the USAF Map-Typing Project Office in Colorado Springs. The data consisted of 00Z and 12Z MSL pressures for December, January and February at 20 grid points in the Mackenzie window over a 27-year period from 1946-1972.

The correlation procedure produced 24 distinct map types. The first three appendices constitute the catalogue of types. The basic information used to assign maps to types is listed in Appendix 1. It includes, in Table 8, the MSL pressures at the 20 grid points for the key maps representing each type. Also listed in the table are the standard deviations of the mean pressure gradient used to assign a gradient class to each type. Appendix 2 contains a chronological listing of all maps and the assigned types. The gradient class of each map is appended to the type designator. The pressure pattern of the key map for each type is illustrated in Appendix 3. Statistical

information on the pressure and occurrence characteristics is listed beneath each key map.

The key map patterns and the mean pressure statistic clearly show the Mackenzie Valley to be dominated by high-pressure systems during the three coldest months. This was anticipated in a region with a highly continental climate. The information on occurrences indicates a high degree of map-type persistence which can be related to the predominance of the continental Arctic air mass.

Just over one-third of all maps did not correlate with any of the types during the map-type assignment procedure. This high percentage of uncorrelated maps reduced the number of maps assigned to the correlated types to such an extent that statistical reliability became a problem when relating hourly weather to individual types.

The wide range of mean pressure gradients between maps of the same type substantiates the conclusions of Scholefield (1973) who used simple hypothetical maps to show that the correlation method does not discriminate between pressure gradients. Classifying map types according to their pressure gradient produced "sub-types" with similar pressure gradients as well as isobaric configurations.

The monthly occurrence statistics in Appendix 3 indicate slight changes in map-type frequencies that can be related to the advance of the winter season. The changes do not appear large enough to prevent an expansion of the three-month cold season. Such an expansion is recommended as a means of combatting statistical reliability problems.

7.2 Yellowknife Weather Related to Map Types

A few good relationships were found between the annual occurrence anomalies of map types and the climatic anomalies of temperature and precipitation. There was no evidence of a trend in map-type occurrences associated with a pronounced cooling trend that began in the late 1940's and continued through the following decade.

The results of summarizing 16 years of hourly observations of aviation weather parameters, present near the time of map type occurrences, were encouraging. In all cases, the frequency of weather parameters relative to a given type were considerably greater than the corresponding climatic frequencies. The four map types that had the highest degree of association with a given parameter were noted. The best associations were found between map types and the highest categories of ceiling and visibility, and the wind direction. The association between types and precipitation was also fairly good. The worst associations were between map types and the lowest ceiling and visibility categories. Despite these poor associations, the best relative frequencies were still significantly larger than the climatic frequencies.

May Type U was never one of the four best types associated with a given weather parameter. This suggests that types which were highly associated with parameters should be better than Type U as a predictor of that parameter. However, verification results of low category ceiling and visibility forecasts showed this not to be the case.

7.3 Predicting Ceiling and Visibility Categories

A simple conditional-probability forecast model was developed based on the frequencies of ceiling and visibility categories associated with map types during a 16-year dependent data sample. The model was tested by calculating P-Scores on probability forecasts over four years of independent data. The skill of these map-type forecasts was measured by comparing their P-Scores with those calculated from forecasts based on pure climatological frequencies.

The overall results showed map-type forecasts to be better than climatological forecasts. Ceilings, being more often of synoptic-scale extent than visibilities, were forecast with greater skill than visibilities. Ceiling forecasts based on the combined map times of 00Z and 12Z were slightly better than those based on individual 00Z or 12Z times only. This was largely due to improved forecast reliability. Verification results of the model based on gradient-stratified map types were the worst of any model, despite improvements in forecast resolution. Over-stratification of the data was entirely responsible for these poor results.

As this study progressed, it became evident that the statistical stability of the data was the most important factor affecting the verification results. P-Scores worsen in every case where the data are stratified too much. Conversely, those stratified weather parameters that occur frequently enough to be statistically stable, are forecast relatively better than overstratified parameters. This factor explains why the map-type-stratified model does not forecast the lowest categories as skillfully as climatology. It also explains

why the low category forecasts associated with the relatively frequent Map Type U are better than those low category forecasts associated with more highly associated, but less frequent types. The excellent verification results shown by map-type forecasts of the highest weather category can be related to the statistical stability of the category-D observations.

An attempt was made to increase the number of observations associated with each type by assigning more than one type to a map when the second highest correlation coefficient was close to the first. The number of correlation types was also increased by lowering the correlation coefficient threshold during the assignment procedure. In both cases there was some improvement in the reliability and P-Scores of the forecasts.

These verification results are promising, considering that no initial weather condition is incorporated, and the only atmospheric predictor is the synoptic weather pattern. There are enough positive results to warrant further study.

7.4 Recommendations for Further Study

To improve this map-type forecast model to the stage where it could be successfully used as an objective aid to aviation forecasting, the following recommendations are made:

(i) The model should be applied to another location in the Mackenzie window and comparisons made with the Yellowknife results.

(ii) There is no need to alter the correlation coefficient threshold ($r = 0.8$) used in developing the map types, but the assignment threshold should be lowered to reduce the number of uncorrelated maps and improve verification results.

(iii) The data base should be expanded by increasing the length of the season, by considering maps at the intermediate hours of 06Z and 18Z, and by obtaining additional hourly data.

(iv) Forecast reliability could be improved by combining the two lowest ceiling and visibility categories; also consideration should be given to other significant parameters, such as precipitation and strong winds which, essentially, have only two categories: occurrence and non-occurrence.

(v) The data should be stratified according to an initial weather condition which introduces local effects and persistence. This should improve the forecast resolution more than the subsequent loss of reliability.

(vi) In addition to the P-Score, the "improved" model should be verified against persistence and official FT's, using contingency table methods. A utility score should be included to measure the operational effectiveness of the forecasts.

(vii) Gradient stratification should be considered for

select types that occur frequently enough to ensure statistical reliability.

(viii) If the "improved" model should produce disappointing results, consideration should be given to redeveloping the map-type catalogue by incorporating derived atmospheric parameters such as vorticity and thickness.

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APPENDIX 1

SURFACE MAP-TYPE WINDOW, GRID-POINT PRESSURE VALUES AND STANDARD DEVIATIONS OF THE MEAN PRESSURE GRADIENT

The surface map type window (dashed lines) is illustrated in Figure 2 with the 20 grid points and the locations within the window for which terminal forecasts are regularly issued. The dates and grid-point pressure values of the key map for each type are listed in Table 8. The standard deviations of the mean pressure, listed in the table, were calculated from all the maps assigned to each type. The units are in mb/grid interval (381 km).

FIGURE 2. MACKENZIE WINDOW
NUMBERED GRID POINTS REFER TO THE ORDER IN WHICH THE PRESSURE VALUES ARE LISTED IN TABLE 8 (SEE BELOW).

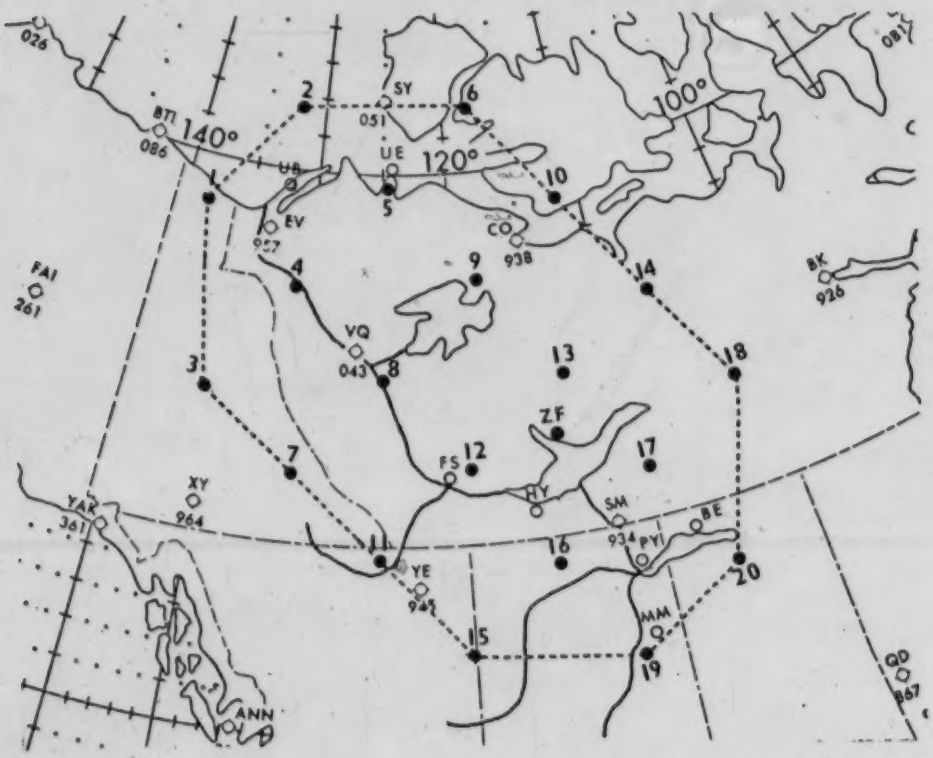

TABLE 8. GRID POINT PRESSURE VALUES AND STANDARD DEVIATIONS OF THE MEAN PRESSURE GRADIENT

MAP TYPE	KEY MAP DATE	S.D. OF MEAN GRADIENT	GRID POINT PRESSURES ON KEY MAP (MSL PRESSURE - 1000 MB)									
1	12Z, 25 FEB 55	1.89	39	38	41	43	38	30	36	40	33	26
			32	35	29	21	30	30	24	17	26	20
2	12Z, 13 DEC 62	1.79	4	16	-1	6	18	28	2	11	22	28
			8	15	25	29	13	18	27	29	19	28
3	12Z, 22 DEC 62	2.09	42	37	41	42	32	16	44	42	29	11
			43	42	29	12	43	42	32	16	40	33
4	12Z, 24 JAN 57	1.93	23	15	50	33	20	15	49	36	27	20
			48	40	34	25	44	38	34	27	38	34
5	12Z, 22 DEC 59	1.68	-2	-2	3	0	-1	6	8	5	5	8
			13	12	14	17	18	18	22	25	24	28
6	12Z, 16 DEC 62	1.49	14	22	2	13	21	24	3	12	19	23
			5	7	13	19	3	1	5	14	-1	0
7	12Z, 3 DEC 60	1.48	27	27	14	24	23	18	7	20	19	13
			1	14	14	9	1	9	10	6	7	9

TABLE 8. GRID POINT PRESSURE VALUES AND STANDARD DEVIATIONS OF THE MEAN PRESSURE GRADIENT (CONTINUED)

MAP TYPE	KEY MAP DATE	S.D. OF MEAN GRADIENT	GRID POINT PRESSURES ON KEY MAP (MSL PRESSURE - 1000 MB)
8	12Z, 21 DEC 63	1.41	14 22 21 22 27 30 26 28 31 31 28 32 34 31 30 34 35 31 34 34
9	12Z, 19 DEC 56	1.19	15 14 6 16 17 11 7 17 18 15 7 15 17 17 7 15 17 17 13 17
10	12Z, 16 FEB 63	1.16	32 34 25 36 34 27 24 35 31 21 27 33 28 21 24 27 25 22 24 23
11	12Z, 30 DEC 57	1.53	21 20 19 22 20 21 20 22 23 26 20 21 25 31 21 20 27 33 24 29
12	12Z, 9 DEC 55	1.64	13 16 0 8 10 15 0 7 7 12 2 3 4 13 5 4 10 20 10 18
13	12Z, 10 FEB 56	1.46	31 24 30 31 24 17 21 27 25 21 14 20 22 23 11 16 21 25 9 18
14	12Z, 27 DEC 59	1.26	18 22 0 13 18 13 4 13 17 15 10 15 19 19 18 20 24 27 28 30
15	12Z, 4 DEC 67	1.78	7 0 -5 4 3 9 -3 4 5 14 -3 0 3 15 -6 -5 3 17 -6 3
16	12Z, 5 DEC 66	1.32	20 11 28 23 13 1 23 24 14 5 14 20 15 11 7 13 16 16 2 12
17	12Z, 19 DEC 61	1.41	28 21 28 28 19 15 27 29 22 15 27 32 28 22 26 33 34 30 34 37
18	12Z, 7 FEB 68	1.17	17 26 14 21 31 41 20 26 35 39 25 28 30 33 26 25 23 24 23 19
19	12Z, 16 FEB 60	0.97	31 32 31 33 36 39 31 34 37 41 29 30 31 31 25 24 24 21 20 23
20	12Z, 19 DEC 60	1.32	38 43 35 45 49 41 39 48 49 38 41 47 44 32 40 45 40 28 41 37
21	12Z, 10 FEB 57	1.07	16 10 8 15 10 8 1 14 11 11 -3 5 7 14 -2 2 9 18 9 16
22	12Z, 3 DEC 70	0.82	29 22 36 30 23 21 33 33 29 27 28 34 34 34 27 30 33 34 27 30
23	12Z, 13 JAN 55	0.78	7 13 13 14 13 18 15 14 10 12 12 11 8 9 8 7 6 10 3 4
24	12Z, 19 FEB 68	0.74	31 36 15 29 32 28 24 30 29 26 28 33 29 23 26 33 31 22 29 29
U		1.47	

APPENDIX 2

CHRONOLOGICAL LISTING OF THE MAP TYPES ASSIGNED TO EACH MAP

The map types that were assigned to each of the 3814 surface maps, using the correlation coefficient threshold of r = 0.8, are listed in chronological order. The first eight-digit number in a group contains the year, month, day and hour (GMT) of the map. The second number is the highest correlation coefficient resulting from the correlation between the map and the 24 map types. This is followed by the designator of the corresponding type which has appended to it a pressure gradient classification, which is either strong (S), medium (M) or weak (W). The second highest correlation coefficient follows next, except for uncorrelated maps (Type U) where asterisks (*) replace the correlation coefficient. If the second highest correlation coefficient is greater than or equal to the threshold value, then the designator of the corresponding type is listed. If this secondary type is listed, and its corresponding correlation coefficient is within 0.05 of the highest correlation coefficient, the type is marked with an asterisk (*).

46010112	0.843	6M	0.681	
46010512	0.946	6S	0.773	
46010912	0.851	1W	0.828	18*
46011312	0.617	UM	*****	11
46011712	0.839	6M	0.702	
46012112	0.519	UM	*****	20
46012512	0.979	3M	0.605	
46012912	0.907	8M	0.645	
46020212	0.686	UW	*****	11
46020612	0.886	6M	0.816	6
46021012	0.718	UM	*****	21
46021412	0.979	2S	0.790	
46021812	0.655	UM	*****	14
46022212	0.831	6M	0.749	
46022612	0.918	2M	0.795	
46120212	0.777	UM	*****	3
46120612	0.931	7M	0.793	
46121012	0.811	3M	0.770	
46121412	0.863	10M	0.857	21*
46121812	0.922	5M	0.678	
46122212	0.659	UW	*****	1
46122612	0.620	UM	*****	11
46123012	0.831	14M	0.720	
47010312	0.843	3W	0.670	
47010712	0.861	4M	0.718	
47011112	0.848	4M	0.838	8*
47011512	0.802	7M	0.788	
47011912	0.869	1M	0.787	
47012312	0.827	15M	0.808	5*
47012712	0.883	16M	0.676	
47013112	0.830	22W	0.712	
47020412	0.795	US	*****	22
47020812	0.905	5W	0.738	
47021212	0.823	9S	0.736	
47021612	0.906	1M	0.779	
47022012	0.806	18W	0.677	
47022412	0.874	2M	0.834	13*
47022812	0.863	6M	0.825	6*
47120412	0.901	8W	0.799	
47120812	0.699	UM	*****	20
47121212	0.847	2M	0.775	
47121612	0.915	2M	0.758	
47122012	0.465	UM	*****	12
47122412	0.533	UM	*****	8
47122812	0.836	2M	0.774	
48010112	0.810	12S	0.722	
48010512	0.716	UM	*****	8
48010912	0.658	UM	*****	21
48011312	0.745	US	*****	19
48011712	0.751	UM	*****	3
48012112	0.915	11S	0.837	7
48012512	0.716	UM	*****	2
48012912	0.839	7M	0.806	5*
48020212	0.752	UM	*****	1
48020612	0.802	1M	0.768	
48021012	0.887	4S	0.750	
48021412	0.802	10M	0.718	
48021812	0.873	4M	0.797	
48022212	0.806	13M	0.792	

46010212	0.752	US	*****	10
46010612	0.712	UW	*****	6
46011012	0.908	1M	0.793	
46011412	0.944	8M	0.764	
46011812	0.747	UM	*****	8
46012212	0.943	1M	0.802	6*
46012612	0.907	1M	0.899	18*
46013012	0.956	2M	0.900	9
46020312	0.732	UW	*****	15
46020712	0.808	6W	0.749	
46021112	0.810	8M	0.725	
46021512	0.863	19M	0.801	15
46021912	0.900	8W	0.861	7*
46022312	0.713	UM	*****	10
46022712	0.781	US	*****	5
46120312	0.625	US	*****	24
46120712	0.912	7M	0.791	
46121112	0.877	1M	0.727	
46121512	0.918	1M	0.889	18*
46121912	0.575	UM	*****	12
46122312	0.778	UM	*****	11
46122712	0.755	UW	*****	12
46123112	0.620	US	*****	22
47010412	0.693	US	*****	1
47010812	0.637	UM	*****	8
47011212	0.935	16M	0.715	
47011612	0.908	13M	0.753	
47012012	0.811	10M	0.807	3*
47012412	0.892	7S	0.781	
47012812	0.813	3M	0.777	
47020112	0.737	UM	*****	10
47020512	0.817	19M	0.767	
47020912	0.915	10S	0.857	3*
47021312	0.788	UM	*****	10
47021712	0.880	20S	0.613	
47022112	0.941	6M	0.718	
47022512	0.930	8M	0.834	7
47120112	0.694	UM	*****	2
47120512	0.818	19M	0.814	15*
47120912	0.856	6W	0.839	17*
47121312	0.832	6M	0.733	
47121712	0.931	2S	0.789	
47122112	0.870	2M	0.761	
47122512	0.821	8W	0.630	
47122912	0.907	2W	0.733	
48010212	0.847	6S	0.655	
48010612	0.775	UM	*****	16
48011012	0.928	7S	0.826	18
48011412	0.848	19S	0.819	15*
48011812	0.931	8S	0.810	12
48012212	0.756	UM	*****	8
48012612	0.858	5S	0.897	2
48013012	0.855	13M	0.623	
48020312	0.813	13S	0.757	
48020712	0.940	1M	0.834	18
48021112	0.893	3W	0.784	
48021512	0.742	UM	*****	11
48021912	0.973	4M	0.650	
48022312	0.821	20W	0.643	

46010312	0.922	12M	0.813	7*
46010712	0.850	6M	0.774	
46011112	0.911	3M	0.736	
46011512	0.854	2M	0.811	23
46011912	0.607	UM	*****	1
46012312	0.908	3W	0.747	
46012712	0.854	7W	0.804	
46013112	0.813	11M	0.774	
46020412	0.769	UM	*****	19
46020812	0.835	9M	0.737	
46021212	0.675	UW	*****	2
46021612	0.873	2M	0.853	2*
46022012	0.887	6M	0.775	
46022412	0.925	9M	0.647	
46022812	0.908	10M	0.768	
46120412	0.802	9M	0.630	
46120812	0.805	7S	0.788	
46121212	0.887	1M	0.690	
46121612	0.706	UM	*****	21
46122012	0.764	US	*****	3
46122412	0.818	10M	0.817	6*
46122812	0.678	UM	*****	19
47010112	0.824	8M	0.797	
47010512	0.854	4W	0.740	
47010912	0.812	1W	0.790	
47011312	0.732	UW	*****	11
47011712	0.807	9M	0.594	
47012112	0.743	UM	*****	10
47012512	0.894	7M	0.886	11*
47012912	0.887	16M	0.852	24*
47020212	0.812	19M	0.726	
47020612	0.690	US	*****	3
47021012	0.897	10M	0.847	3*
47021412	0.865	2M	0.786	
47021812	0.893	20M	0.672	
47022212	0.931	2S	0.815	14
47022612	0.661	UM	*****	6
47120212	0.855	5W	0.848	2*
47120612	0.914	2W	0.749	
47121012	0.763	UM	*****	19
47121412	0.829	18M	0.703	
47121812	0.889	12S	0.822	7
47122212	0.790	UM	*****	12
47122612	0.721	UM	*****	15
47123012	0.884	8M	0.862	7*
48010312	0.640	UM	*****	21
48010712	0.847	20M	0.753	
48011112	0.862	10M	0.845	3*
48011512	0.657	UM	*****	2
48011912	0.762	UM	*****	15
48012312	0.758	UW	*****	1
48012712	0.776	US	*****	12
48013112	0.766	US	*****	3
48020412	0.861	4M	0.839	4*
48020812	0.761	US	*****	1
48021212	0.862	1M	0.769	
48021612	0.765	UM	*****	22
48022012	0.816	5M	0.815	8*
48022412	0.899	9M	0.790	

46010412	0.933	6M	0.704	
46010812	0.558	UM	*****	19
46011212	0.733	UM	*****	10
46011612	0.908	18M	0.828	5
46012012	0.848	5M	0.867	2
46012412	0.972	1M	0.832	18
46012812	0.801	9M	0.653	
46020112	0.803	21W	0.787	
46020512	0.785	UM	*****	6
46020912	0.787	US	*****	6
46021312	0.821	18S	0.732	
46021712	0.899	2M	0.708	
46022112	0.875	6M	0.730	
46022512	0.831	18M	0.729	
46120112	0.718	UM	*****	24
46120512	0.911	6W	0.788	
46120912	0.907	1M	0.662	
46121312	0.906	1M	0.720	
46121712	0.946	8S	0.809	12
46122112	0.823	22M	0.598	
46122512	0.736	UM	*****	18
46122912	0.840	20M	0.565	
47010212	0.888	5M	0.718	
47010612	0.821	4W	0.420	
47011012	0.765	US	*****	1
47011412	0.788	UM	*****	2
47011812	0.868	6S	0.812	6
47012212	0.924	9M	0.798	
47012612	0.808	13M	0.808	3*
47013012	0.797	UM	*****	24
47020312	0.849	1M	0.829	4*
47020712	0.770	UM	*****	2
47021112	0.871	10M	0.787	
47021512	0.629	UM	*****	22
47021912	0.741	UM	*****	14
47022312	0.975	2S	0.750	
47022712	0.872	6M	0.748	
47123312	0.657	UM	*****	4
47123712	0.809	2W	0.742	
47121112	0.754	UW	*****	19
47121512	0.751	UW	*****	21
47121912	0.742	UM	*****	14
47122312	0.837	14M	0.751	
47122712	0.670	UM	*****	21
47123112	0.977	2S	0.741	
48010412	0.682	UW	*****	18
48010812	0.880	14M	0.727	
48011212	0.843	1M	0.821	4*
48011612	0.943	5M	0.721	
48012012	0.748	UW	*****	2
48012412	0.793	US	*****	22
48012812	0.705	UM	*****	9
48020112	0.541	UM	*****	2
48020512	0.832	4M	0.761	
48020912	0.863	3S	0.817	1*
48021312	0.892	1S	0.855	4*
48021712	0.864	4M	0.793	
48022112	0.942	21M	0.782	
48022512	0.936	6M	0.742	

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51012612	0.871	4M	0.817	4	51012712	0.910	4M	0.582		51012812	0.892	4M	0.783		51012912	0.837	1S	0.835	4*
51013012	0.879	3S	0.781		51013112	0.783	US	*****	1	51020112	0.891	1S	0.855	4*	51020212	0.767	UM	*****	4
51020312	0.872	10M	0.817	3	51020412	0.845	17M	0.719		51020512	0.751	US	*****	1	51020612	0.897	3M	0.730	
51020712	0.810	3W	0.690		51020812	0.812	9M	0.737		51020912	0.902	13M	0.693		51021012	0.919	3M	0.826	1
51021112	0.852	4M	0.848	4*	51021212	0.885	4M	0.805	8	51021312	0.793	US	*****	12	51021412	0.759	UM	*****	8
51021512	0.772	UM	*****	11	51021612	0.803	15M	0.742		51021712	0.757	US	*****	16	51021812	0.760	UM	*****	5
51021912	0.884	21M	0.840	20*	51022012	0.869	1M	0.804	18	51022112	0.861	8M	0.597		51022212	0.742	UM	*****	13
51022312	0.743	UM	*****	7	51022412	0.893	7M	0.770		51022512	0.689	US	*****	10	51022612	0.870	8S	0.760	
51022712	0.910	5M	0.870	13*	51022812	0.808	22M	0.670		51120112	0.841	15M	0.782		51120212	0.796	UM	*****	15
51120312	0.862	18W	0.568		51120412	0.930	18M	0.743		51120512	0.851	2M	0.837	14*	51120612	0.901	2M	0.785	
51120712	0.811	11W	0.666		51120812	0.834	14W	0.693		51120912	0.813	7M	0.803	3*	51121012	0.807	20M	0.765	
51121112	0.714	UM	*****	6	51121212	0.828	1M	0.798		51121312	0.927	1S	0.822	4	51121412	0.937	3S	0.750	
51121512	0.810	4M	0.721		51121612	0.806	1W	0.510		51121712	0.881	4W	0.702		51121812	0.931	4M	0.686	
51121912	0.793	US	*****	12	51122012	0.533	UM	*****	12	51122112	0.655	UW	*****	24	51122212	0.814	4M	0.791	
51122312	0.765	UM	*****	1	51122412	0.760	UM	*****	3	51122512	0.936	1M	0.781		51122612	0.914	4S	0.627	
51122712	0.944	4S	0.789		51122812	0.711	US	*****	3	51122912	0.896	1M	0.667		51123012	0.821	5M	0.727	
51123112	0.928	5M	0.829	2	52010112	0.956	5M	0.646		52010212	0.575	UM	*****	22	52010312	0.702	UM	*****	1
52010412	0.954	5M	0.852	2	52010512	0.735	UM	*****	22	52010612	0.820	10M	0.727		52010712	0.902	13S	0.851	22
52010812	0.821	3W	0.790		52010912	0.841	9M	0.643		52011012	0.922	13M	0.665		52011112	0.718	UM	*****	24
52011212	0.949	5M	0.842	2	52011312	0.846	7S	0.813	11*	52011412	0.832	4M	0.776		52011512	0.796	US	*****	12
52011612	0.662	UM	*****	12	52011712	0.832	7M	0.752		52011812	0.883	7M	0.853	17*	52011912	0.898	7M	0.810	17
52012012	0.833	7M	0.833	3*	52012112	0.840	1M	0.836	18*	52012212	0.893	1M	0.800		52012312	0.907	1M	0.735	
52012412	0.838	1S	0.749		52012512	0.841	23M	0.829	17*	52012612	0.864	3M	0.713		52012712	0.803	4M	0.623	
52012812	0.815	8W	0.801	9*	52012912	0.838	7W	0.790		52013012	0.912	7M	0.825	18	52013112	0.810	10M	0.618	
52020112	0.881	9M	0.713		52020212	0.760	UW	*****	5	52020312	0.697	UW	*****	10	52020412	0.863	9W	0.707	
52020512	0.838	1W	0.677		52020612	0.913	6M	0.830	17	52020712	0.847	2W	0.738		52020812	0.835	18M	0.700	
52020912	0.818	2M	0.749		52021012	0.744	UW	*****	6	52021112	0.899	13W	0.746		52021212	0.805	6M	0.795	
52021312	0.687	UW	*****	5	52021412	0.792	UM	*****	20	52021512	0.847	21M	0.761		52021612	0.906	13M	0.797	
52021712	0.845	7W	0.777		52021812	0.804	12W	0.795		52021912	0.791	UM	*****	20	52022012	0.757	UW	*****	10
52022112	0.812	12W	0.729		52022212	0.782	UW	*****	10	52022312	0.840	11W	0.781		52022412	0.721	UW	*****	19
52022512	0.834	6W	0.618		52022612	0.866	6W	0.705		52022712	0.802	6W	0.786		52022812	0.966	2M	0.729	
52022912	0.803	6W	0.771		52120112	0.785	UM	*****	10	52120212	0.970	2M	0.819	13	52120312	0.845	2M	0.844	20*
52120412	0.785	UM	*****	5	52120512	0.812	15M	0.687		52120612	0.823	18W	0.819	5*	52120712	0.898	6W	0.792	
52120812	0.838	6W	0.681		52120912	0.917	8W	0.738		52121012	0.733	UW	*****	13	52121112	0.841	5W	0.813	8*
52121212	0.931	5W	0.718		52121312	0.810	14S	0.802	12*	52121412	0.506	UM	*****	8	52121512	0.844	1M	0.824	4*
52121612	0.820	20M	0.730		52121712	0.636	UM	*****	2	52121812	0.394	UW	*****	20	52121912	0.833	10W	0.779	
52122012	0.667	UW	*****	10	52122112	0.687	UW	*****	18	52122212	0.768	UW	*****	14	52122312	0.826	2W	0.702	
52122412	0.726	UM	*****	20	52122512	0.919	2M	0.805	14	52122612	0.774	UM	*****	2	52122712	0.758	UM	*****	14
52122812	0.872	11M	0.854	9*	52122912	0.876	12W	0.755		52123012	0.877	6M	0.742		52123112	0.882	18M	0.808	5
53010112	0.793	UM	*****	2	53010212	0.815	18W	0.638		53010312	0.844	18W	0.809	5*	53010412	0.824	22W	0.621	
53010512	0.923	1M	0.767		53010612	0.935	1M	0.740		53010712	0.938	1M	0.785		53010812	0.766	UM	*****	5
53010912	0.583	UW	*****	16	53011012	0.920	1W	0.757		53011112	0.882	3M	0.866	3*	53011212	0.812	16S	0.777	
53011312	0.899	3M	0.873	1*	53011412	0.894	17S	0.823	1	53011512	0.841	17M	0.833	4*	53011612	0.828	16S	0.727	
53011712	0.669	UM	*****	8	53011812	0.849	9W	0.543		53011912	0.788	UM	*****	7	53012012	0.845	18M	0.843	7*
53012112	0.900	2W	0.790		53012212	0.930	2M	0.809	14	53012312	0.811	13M	0.654		53012412	0.823	1M	0.797	
53012512	0.855	13S	0.835	6*	53012612	0.871	1S	0.753		53012712	0.854	3M	0.787		53012812	0.844	3M	0.656	
53012912	0.917	1M	0.764		53013012	0.822	1W	0.781		53013112	0.757	UM	*****	10	53020112	0.856	15M	0.826	7*
53020212	0.831	15S	0.789		53020312	0.901	11M	0.863	7*	53020412	0.780	UW	*****	23	53020512	0.844	13W	0.664	
53020612	0.701	UM	*****	11	53020712	0.860	21S	0.813	10*	53020812	0.849	18W	0.789		53020912	0.863	14S	0.837	12*
53021012	0.645	US	*****	4	53021112	0.792	UM	*****	4	53021212	0.510	UM	*****	14	53021312	0.907	18M	0.794	
53021412	0.975	2S	0.724		53021512	0.950	2S	0.763		53021612	0.885	2M	0.703		53021712	0.838	18S	0.835	5*
53021812	0.736	UM	*****	2	53021912	0.898	8M	0.801	12	53022012	0.966	5M	0.670		53022112	0.731	UM	*****	4
53022212	0.918	1M	0.681		53022312	0.797	UM	*****	9	53022412	0.342	US	*****	20	53022512	0.808	18M	0.664	
53022612	0.875	19M	0.808	15	53022712	0.542	UW	*****	24	53022812	0.904	17W	0.820	12	53120112	0.750	UM	*****	15
53120212	0.729	UW	*****	10	53120312	0.843	15M	0.748		53120412	0.859	18M	0.856	5*	53120512	0.857	2M	0.781	
53120612	0.906	6M	0.748		53120712	0.815	19M	0.800	5*	53120812	0.757	UW	*****	7	53120912	0.802	6M	0.792	
53121012	0.890	6W	0.744		53121112	0.866	2M	0.844	20*	53121212	0.956	6M	0.837	17	53121312	0.798	UW	*****	14
53121412	0.822	21M	0.772		53121512	0.805	4W	0.579		53121612	0.829	14W	0.656		53121712	0.761	UM	*****	20
53121812	0.975	6M	0.760		53121912	0.958	6M	0.818	17*	53122012	0.863	7W	0.846	18*	53122112	0.912	8W	0.588	
53122212	0.862	5S	0.782		53122312	0.802	18*	0.605		53122412	0.890	6M	0.839	17	53122512	0.727	UW	*****	17

53122612	0.813	13M	0.800		53122712	0.905	10M	0.888	6*	53122812	0.835	7M	0.797		53122912	0.634	UM	*****	4
53123012	0.719	UM	*****	19	53123112	0.852	7M	0.848	18*	54010112	0.935	9M	0.636		54010212	0.817	7M	0.748	
54010312	0.807	7M	0.771		54010412	0.830	9M	0.644		54010512	0.717	UM	*****	19	54010612	0.881	2M	0.749	
54010712	0.926	2S	0.825	2	54010812	0.855	5S	0.846	2*	54010912	0.893	5M	0.735		54011012	0.795	UM	*****	12
54011112	0.800	US	*****	4	54011212	0.731	US	*****	18	54011312	0.839	3M	0.769		54011412	0.957	1E	0.683	
54011512	0.926	4M	0.759		54011612	0.902	1M	0.659		54011712	0.877	4S	0.832	8*	54011812	0.889	1M	0.778	
54011912	0.874	1M	0.797		54012012	0.837	1M	0.696		54012112	0.859	4S	0.830	8*	54012212	0.844	3S	0.795	
54012312	0.829	3M	0.782		54012412	0.929	1M	0.781		54012512	0.924	3M	0.759		54012612	0.838	1W	0.811	18*
54012712	0.759	UM	*****	8	54012812	0.818	22M	0.598		54012912	0.880	5M	0.664		54013012	0.910	2M	0.871	9*
54013112	0.404	UM	*****	3	54020112	0.630	UM	*****	18	54020212	0.919	14S	0.868	7	54020312	0.897	1M	0.686	
54020412	0.844	14M	0.648		54020512	0.813	18M	0.510		54020612	0.786	US	*****	12	54020712	0.855	3M	0.583	
54020812	0.724	UM	*****	13	54020912	0.898	1M	0.742		54021012	0.882	1M	0.776		54021112	0.947	4S	0.783	
54021212	0.935	1S	0.790		54021312	0.863	3M	0.789		54021412	0.820	4E	0.816	8*	54021512	0.876	17M	0.758	
54021612	0.918	17M	0.633		54021712	0.685	UM	*****	10	54021812	0.787	US	*****	24	54021912	0.768	UW	*****	24
54022012	0.716	UM	*****	1	54022112	0.909	5M	0.829	2	54022212	0.894	5W	0.696		54022312	0.641	UM	*****	20
54022412	0.667	UM	*****	10	54022512	0.721	US	*****	6	54022612	0.910	1M	0.678		54022712	0.719	UM	*****	1
54022812	0.855	16M	0.767		54120112	0.720	UM	*****	2	54120212	0.812	4M	0.746		54120312	0.857	7M	0.825	18*
54120412	0.855	21M	0.840	11*	54120512	0.589	UM	*****	23	54120612	0.760	UM	*****	1	54120712	0.624	UW	*****	22
54120812	0.837	5W	0.708		54120912	0.725	UM	*****	16	54121012	0.790	UM	*****	17	54121112	0.874	2M	0.869	13*
54121212	0.650	UM	*****	3	54121312	0.889	13M	0.672		54121412	0.853	9M	0.793		54121512	0.841	19M	0.658	
54121612	0.771	UM	*****	12	54121712	0.825	5W	0.651		54121812	0.816	3M	0.612		54121912	0.781	UM	*****	23
54122012	0.822	2M	0.789		54122112	0.654	UM	*****	14	54122212	0.931	6M	0.835	17	54122312	0.842	13W	0.803	6*
54122412	0.855	13M	0.695		54122512	0.871	7W	0.803	3	54122612	0.848	9M	0.624		54122712	0.916	13M	0.755	
54122812	0.873	16S	0.668		54122912	0.954	4S	0.773		54123012	0.799	UM	*****	1	54123112	0.857	16M	0.724	
55010112	0.900	4W	0.612		55010212	0.870	5M	0.827	2*	55010312	0.790	US	*****	9	55010412	0.792	UM	*****	3
55010512	0.821	2W	0.757		55010612	0.836	11W	0.820	7*	55010712	0.711	UM	*****	16	55010812	0.781	UM	*****	3
55010912	0.755	UM	*****	2	55011012	0.808	8M	0.772		55011112	0.906	5M	0.843	2	55011212	0.892	5W	0.877	13*
55011312	1.000	23W	0.722		55011412	0.670	UM	*****	14	55011512	0.864	6M	0.773		55011612	0.982	18M	0.842	5*
55011712	0.828	2M	0.802	2*	55011812	0.901	2M	0.883	2*	55011912	0.892	5M	0.824	13	55012012	0.267	UM	*****	20
55012112	0.782	UM	*****	3	55012212	0.871	2M	0.768		55012312	0.747	UM	*****	5	55012412	0.912	18W	0.695	
55012512	0.912	2M	0.813	2	55012612	0.547	UW	*****	12	55012712	0.817	8W	0.591		55012812	0.788	UM	*****	11
55012912	0.870	7W	0.650		55013012	0.946	7M	0.855	18	55013112	0.856	9M	0.853	7*	55020112	0.797	UM	*****	16
55020212	0.831	2W	0.791		55020312	0.730	UM	*****	20	55020412	0.877	6M	0.812	17	55020512	0.883	6W	0.774	
55020612	0.831	9S	0.812	16*	55020712	0.865	7S	0.843	5*	55020812	0.849	7M	0.819	11*	55020912	0.814	17M	0.641	
55021012	0.681	UM	*****	8	55021112	0.871	2S	0.830	9*	55021212	0.872	12M	0.815	23	55021312	0.932	7W	0.704	
55021412	0.935	11M	0.737		55021512	0.790	UW	*****	5	55021612	0.825	7M	0.792		55021712	0.833	1M	0.636	
55021812	0.815	5M	0.795		55021912	0.555	UM	*****	22	55022012	0.843	7M	0.797		55022112	0.879	13S	0.746	
55022212	0.909	3M	0.872	3*	55022312	0.844	17W	0.737		55022412	0.712	US	*****	3	55022512	1.000	1M	0.781	
55022612	0.909	4M	0.649		55022712	0.776	UM	*****	20	55022812	0.823	7M	0.819	5*	55120100	0.847	6M	0.793	
55120112	0.839	2M	0.736		55120200	0.820	2M	0.811	13*	55120212	0.836	5M	0.784		55120300	0.600	UM	*****	9
55120312	0.903	7M	0.774		55120400	0.883	10M	0.871	6*	55120412	0.695	UM	*****	19	55120500	0.828	17M	0.528	
55120512	0.948	17M	0.656		55120600	0.754	UM	*****	6	55120612	0.943	7S	0.781		55120700	0.928	7M	0.882	18*
55120712	0.783	UM	*****	10	55120800	0.868	9M	0.854	7*	55120812	0.917	2S	0.835	20	55120900	0.950	12M	0.786	
55120912	1.000	12M	0.717		55121000	0.889	12M	0.760		55121012	0.739	UM	*****	16	55121100	0.775	UM	*****	6
55121112	0.894	1M	0.743		55121200	0.854	13M	0.765		55121212	0.761	US	*****	3	55121300	0.612	US	*****	22
55121312	0.810	4M	0.407		55121400	0.931	4M	0.544		55121412	0.916	4M	0.659		55121500	0.965	4M	0.582	
55121512	0.846	4M	0.531		55121600	0.674	US	*****	3	55121612	0.899	1M	0.671		55121700	0.940	1E	0.789	
55121712	0.877	1M	0.797		55121800	0.813	3M	0.807	3*	55121812	0.770	US	*****	3	55121900	0.851	1M	0.799	
55121912	0.837	3M	0.749		55122000	0.792	UM	*****	8	55122012	0.777	US	*****	12	55122100	0.818	5M	0.593	
55122112	0.756	UM	*****	13	55122200	0.730	UM	*****	13	55122212	0.695	UM	*****	13	55122300	0.650	UM	*****	24
55122312	0.623	UM	*****	3	55122400	0.904	1M	0.610		55122412	0.963	1M	0.650		55122500	0.710	UM	*****	3
55122512	0.701	UM	*****	1	55122600	0.736	US	*****	12	55122612	0.810	22M	0.676		55122700	0.950	4M	0.614	
55122712	0.907	4S	0.559		55122800	0.853	5S	0.729		55122812	0.789	US	*****	12	55122900	0.795	US	*****	8
55122912	0.769	US	*****	12	55123000	0.506	UM	*****	12	55123012	0.473	UM	*****	19	55123100	0.644	UM	*****	14
55123112	0.800	12M	0.660		56010100	0.829	7M	0.692		56010112	0.876	7S	0.757		56010200	0.843	7S	0.795	
56010212	0.860	6M	0.824	17*	56010300	0.774	UM	*****	23	56010312	0.697	UM	*****	2	56010400	0.790	UW	*****	20
56010412	0.958	7S	0.752		56010500	0.894	7S	0.826	11	56010512	0.758	US	*****	11	56010600	0.770	US	*****	24
56010612	0.748	US	*****	24	56010700	0.732	US	*****	13	56010712	0.749	UM	*****	12	56010800	0.759	UM	*****	12
56010812	0.816	4W	0.802	24*	56010900	0.814	17W	0.786		56010912	0.898	16W	0.764		56011000	0.835	13M	0.811	22*
56011012	0.816	13M	0.806	3*	56011100	0.714	UM	*****	3	56011112	0.673	UM	*****	3	56011200	0.697	UM	*****	24

56011212	0.766	UM	*****	1	56011300	0.748	UM	*****	24	56011312	0.738	UM	*****	22	56011400	0.857	4W	0.805	24
56011412	0.855	4M	0.794		56011500	0.811	17M	0.799		56011512	0.920	4M	0.770		56011600	0.811	17S	0.808	1*
56011612	0.949	17S	0.727		56011700	0.732	UM	*****	9	56011712	0.890	14M	0.777		56011800	0.884	14M	0.833	20
56011812	0.875	12M	0.847	9*	56011900	0.934	12M	0.862	9	56011912	0.616	UM	*****	9	56012000	0.827	9M	0.792	
56012012	0.909	12M	0.765		56012100	0.783	UM	*****	20	56012112	0.679	UM	*****	19	56012200	0.775	UM	*****	10
56012212	0.803	2M	0.771		56012300	0.867	12S	0.864	7*	56012312	0.905	12M	0.796		56012400	0.884	12M	0.768	
56012412	0.768	UM	*****	16	56012500	0.865	11M	0.764		56012512	0.862	13M	0.741		56012600	0.827	19M	0.825	5*
56012612	0.895	6M	0.852	17*	56012700	0.790	UM	*****	17	56012712	0.596	UW	*****	24	56012800	0.768	UM	*****	24
56012812	0.892	4M	0.681		56012900	0.968	4M	0.645		56012912	0.975	4M	0.662		56013000	0.921	4M	0.614	
56013012	0.959	4M	0.719		56013100	0.844	4M	0.804	8*	56013112	0.816	4M	0.800		56020100	0.795	UM	*****	1
56020112	0.757	UM	*****	8	56020200	0.844	17S	0.668		56020212	0.765	UM	*****	8	56020300	0.847	3W	0.525	
56020312	0.869	3W	0.784		56020400	0.938	1W	0.761		56020412	0.779	UM	*****	11	56020500	0.729	UM	*****	10
56020512	0.786	UM	*****	13	56020600	0.777	UM	*****	13	56020612	0.878	22W	0.641		56020700	0.852	4W	0.829	24*
56020712	0.843	4M	0.821	8*	56020800	0.645	UM	*****	19	56020812	0.744	UM	*****	6	56020900	0.895	6M	0.683	
56020912	0.797	US	*****	10	56021000	0.843	9S	0.822	16*	56021012	1.000	13M	0.703		56021100	0.922	13M	0.676	
56021112	0.847	16M	0.820	11*	56021200	0.873	16M	0.784		56021212	0.901	16M	0.761		56021300	0.865	16W	0.740	
56021312	0.793	UM	*****	3	56021400	0.808	4M	0.652		56021412	0.983	4M	0.666		56021500	0.894	4M	0.847	8*
56021512	0.900	5M	0.782		56021600	0.854	14M	0.813	12*	56021612	0.950	12M	0.840	16	56021700	0.847	7W	0.800	
56021712	0.886	10M	0.813	6	56021800	0.818	9M	0.714		56021812	0.853	21S	0.820	6*	56021900	0.862	13S	0.817	6*
56021912	0.844	13M	0.691		56022000	0.752	UM	*****	6	56022012	0.797	UM	*****	11	56022100	0.829	13M	0.729	
56022112	0.675	UM	*****	23	56022200	0.799	US	*****	23	56022212	0.763	US	*****	13	56022300	0.795	US	*****	13
56022312	0.755	US	*****	13	56022400	0.788	UM	*****	7	56022412	0.685	UM	*****	23	56022500	0.739	UW	*****	14
56022512	0.723	UM	*****	1	56022600	0.803	5W	0.646		56022612	0.606	UW	*****	20	56022700	0.795	UW	*****	3
56022712	0.857	10W	0.840	6*	56022800	0.823	10W	0.817	19*	56022812	0.799	UM	*****	19	56022900	0.917	9M	0.750	
56022912	0.829	21S	0.810	23*	56120100	0.687	1M	0.681		56120112	0.864	7S	0.858	3*	56120200	0.934	1S	0.810	6
56120212	0.958	1S	0.676		56120300	0.869	3S	0.794		56120312	0.912	3M	0.804	3	56120400	0.845	3M	0.834	3*
56120412	0.776	US	*****	4	56120500	0.933	4M	0.755		56120512	0.945	4M	0.744		56120600	0.846	4M	0.803	4*
56120612	0.845	3M	0.685		56120700	0.836	1M	0.801	4*	56120712	0.922	1M	0.743		56120800	0.903	1M	0.836	4
56120812	0.821	3M	0.726		56120900	0.907	3M	0.768		56120912	0.955	3M	0.651		56121000	0.708	UM	*****	4
56121012	0.844	1M	0.803	22*	56121100	0.845	1S	0.832	4*	56121112	0.853	4M	0.796		56121212	0.869	4M	0.750	
56121300	0.880	22M	0.690		56121312	0.842	22M	0.667		56121400	0.770	US	*****	24	56121412	0.777	UM	*****	22
56121500	0.809	3M	0.787		56121512	0.820	16M	0.757		56121600	0.827	16M	0.782		56121612	0.889	4M	0.831	8
56121700	0.899	17M	0.698		56121712	0.864	21M	0.837	10*	56121800	0.835	21M	0.817	23*	56121812	0.784	UM	*****	6
56121900	0.803	10W	0.697		56121912	1.000	9M	0.704		56122000	0.773	UM	*****	10	56122012	0.853	9M	0.640	
56122100	0.874	9M	0.766		56122112	0.714	UM	*****	24	56122200	0.803	22W	0.785		56122212	0.791	UM	*****	24
56122300	0.788	UM	*****	24	56122312	0.849	22S	0.767		56122400	0.690	UM	*****	8	56122412	0.825	11M	0.691	
56122500	0.862	5W	0.727		56122512	0.848	11M	0.727		56122600	0.635	UM	*****	3	56122612	0.597	UM	*****	21
56122700	0.815	10W	0.683		56122712	0.936	1W	0.808	18	56122800	0.615	UM	*****	19	56122812	0.954	2M	0.779	
56122900	0.920	2M	0.742		56122912	0.800	11M	0.740		56123000	0.687	UM	*****	15	56123012	0.736	UM	*****	17
56123100	0.824	9M	0.707		56123112	0.845	12M	0.825	16*	57010100	0.876	21M	0.839	20*	57010112	0.737	UM	*****	6
57010212	0.641	UW	*****	7	57010300	0.752	UM	*****	20	57010312	0.746	UM	*****	14	57010400	0.563	UM	*****	14
57010412	0.822	5M	0.606		57010500	0.864	17M	0.848		57010512	0.739	UM	*****	8	57010600	0.896	1S	0.716	
57010612	0.888	10S	0.867	3*	57010700	0.814	16S	0.721		57010712	0.841	16S	0.833	4*	57010800	0.913	3S	0.762	
57010812	0.914	3M	0.822	1	57010900	0.894	3S	0.785		57010912	0.855	3M	0.807	3*	57011000	0.896	1S	0.754	
57011012	0.935	1S	0.756		57011100	0.906	3S	0.730		57011112	0.731	US	*****	3	57011200	0.963	4M	0.508	
57011212	0.805	5M	0.759		57011300	0.845	4M	0.790		57011312	0.792	US	*****	4	57011400	0.914	1S	0.781	
57011412	0.790	US	*****	4	57011500	0.943	4S	0.515		57011512	0.945	4S	0.701		57011600	0.861	3S	0.835	1*
57011612	0.908	3S	0.774		57011700	0.945	4S	0.632		57011712	0.869	4S	0.788		57011800	0.877	3S	0.805	1
57011812	0.884	3M	0.741		57011900	0.887	1M	0.716		57011912	0.744	US	*****	1	57012000	0.918	4M	0.719	
57012012	0.785	UM	*****	4	57012100	0.833	3M	0.738		57012112	0.931	3M	0.693		57012200	0.856	3M	0.834	3*
57012212	0.913	1M	0.781		57012300	0.934	3M	0.739		57012312	0.884	3M	0.749		57012400	0.825	4M	0.815	4*
57012412	1.000	4S	0.642		57012500	0.890	4S	0.775		57012512	0.720	US	*****	4	57012600	0.805	4M	0.576	
57012612	0.917	4M	0.617		57012700	0.866	4M	0.487		57012712	0.545	UM	*****	22	57012800	0.822	16W	0.659	
57012812	0.695	UM	*****	8	57012900	0.375	UM	*****	20	57012912	0.896	1W	0.726		57013000	0.849	20W	0.632	
57013012	0.722	UM	*****	10	57013100	0.795	UM	*****	3	57013112	0.783	UM	*****	4	57020100	0.960	4S	0.764	
57020112	0.857	4S	0.788		57020200	0.926	3S	0.672		57020212	0.857	3M	0.776		57020300	0.906	1M	0.759	
57020312	0.902	1M	0.846	4	57020400	0.909	1M	0.807	4	57020412	0.912	1S	0.738		57020500	0.962	4M	0.742	
57020512	0.725	US	*****	4	57020600	0.818	1M	0.512		57020612	0.701	UM	*****	4	57020700	0.766	UM	*****	8
57020712	0.671	UW	*****	13	57020800	0.844	12W	0.844	9*	57020812	0.786	UM	*****	10	57020900	0.881	9M	0.725	
57020912	0.861	9M	0.750		57021000	0.869	21M	0.773		57021012	1.000	21M	0.717		57021100	0.865	13M	0.850	6*

57021112	0.876	1M	0.732		57021200	0.852	1W	0.722		57021212	0.626	UM	*****	3	57021300	0.683	UM	*****	10
57021312	0.967	2S	0.757		57021400	0.862	12S	0.812	7	57021412	0.785	US	*****	3	57021500	0.946	1M	0.678	
57021512	0.762	UM	*****	21	57021600	0.859	14S	0.841	7*	57021612	0.817	7M	0.771		57021700	0.887	1M	0.795	
57021712	0.910	10M	0.831	21	57021800	0.961	7M	0.712		57021812	0.904	7M	0.795		57021900	0.814	20M	0.709	
57021912	0.725	UW	*****	17	57022000	0.925	7W	0.702		57022012	0.892	7M	0.821	17	57022100	0.867	10S	0.843	6*
57022112	0.962	1M	0.789		57022200	0.867	1M	0.673		57022212	0.846	19M	0.754		57022300	0.678	UM	*****	21
57022312	0.710	UM	*****	12	57022400	0.841	14M	0.726		57022412	0.858	9M	0.720		57022500	0.860	6M	0.744	
57022512	0.852	24M	0.582		57022600	0.932	2M	0.865	9*	57022612	0.894	12M	0.828	7	57022700	0.885	12M	0.837	23*
57022712	0.721	UW	*****	5	57022800	0.837	1W	0.686		57022812	0.607	UM	*****	14	57120100	0.831	7W	0.780	
57120112	0.686	UW	*****	6	57120200	0.681	UW	*****	6	57120212	0.780	UM	*****	14	57120300	0.856	2M	0.745	
57120312	0.884	6M	0.856	14*	57120400	0.842	6M	0.750		57120412	0.868	6M	0.715		57120500	0.820	18M	0.755	
57120512	0.912	2W	0.791		57120600	0.946	2M	0.821	2	57120612	0.980	2W	0.771		57120700	0.824	2W	0.765	
57120712	0.627	UW	*****	2	57120800	0.932	8W	0.780		57120812	0.878	2S	0.872	13*	57120900	0.698	UM	*****	23
57120912	0.689	UM	*****	22	57121000	0.922	8M	0.733		57121012	0.928	5M	0.724		57121100	0.889	2M	0.812	2
57121112	0.919	2M	0.720		57121200	0.832	6M	0.798		57121212	0.823	6M	0.804	17*	57121300	0.846	19W	0.813	5*
57121312	0.796	UW	*****	14	57121400	0.821	2W	0.765		57121412	0.823	12W	0.800	7*	57121500	0.842	6W	0.727	
57121512	0.737	UW	*****	5	57121600	0.698	UM	*****	6	57121612	0.719	UM	*****	6	57121700	0.880	9S	0.808	16
57121712	0.888	6S	0.814	23	57121800	0.814	6M	0.807	6*	57121812	0.824	19S	0.777		57121900	0.871	19M	0.815	5
57121912	0.929	6M	0.765		57122000	0.946	6M	0.742		57122012	0.897	6W	0.773		57122100	0.830	9M	0.739	
57122112	0.708	UM	*****	10	57122200	0.817	9W	0.616		57122212	0.687	UM	*****	10	57122300	0.891	9M	0.787	
57122312	0.867	9S	0.829	16*	57122400	0.929	6M	0.809	6	57122412	0.894	19S	0.838	5	57122500	0.905	19S	0.869	5*
57122512	0.857	18M	0.804	5	57122600	0.794	UM	*****	23	57122612	0.852	15S	0.813	5*	57122700	0.866	15S	0.803	5
57122712	0.922	2M	0.791		57122800	0.930	2S	0.815	13	57122812	0.897	11S	0.878	7*	57122900	0.898	11S	0.842	20*
57122912	0.910	11M	0.769		57123000	0.945	11M	0.683		57123012	1.000	11M	0.729		57123100	0.878	14M	0.854	7*
57123112	0.956	12M	0.765		58010100	0.827	12W	0.814	16*	58010112	0.792	UM	*****	6	58010200	0.795	UM	*****	10
58010212	0.776	UM	*****	10	58010300	0.873	2M	0.787		58010312	0.902	2M	0.757		58010400	0.835	12M	0.741	
58010412	0.709	UM	*****	5	58010500	0.821	1M	0.693		58010512	0.625	UM	*****	17	58010600	0.897	2M	0.887	2*
58010612	0.849	2S	0.845	12*	58010700	0.901	2M	0.723		58010712	0.789	US	*****	7	58010800	0.542	US	*****	20
58010812	0.575	US	*****	1	58010900	0.881	7M	0.746		58010912	0.833	7M	0.821	18*	58011000	0.670	UM	*****	22
58011012	0.707	UM	*****	18	58011100	0.759	UM	*****	22	58011112	0.801	1M	0.779		58011200	0.902	1W	0.838	18
58011212	0.931	10M	0.821	21	58011300	0.797	UM	*****	21	58011312	0.775	UM	*****	8	58011400	0.862	17S	0.574	
58011412	0.759	UM	*****	10	58011500	0.808	2S	0.739		58011512	0.877	2W	0.827	2	58011600	0.904	2M	0.857	2*
58011612	0.871	2S	0.837	2*	58011700	0.924	11S	0.830	7	58011712	0.952	11S	0.778		58011800	0.909	11M	0.776	
58011812	0.790	UM	*****	7	58011900	0.935	2S	0.849	13	58011912	0.900	2S	0.825	12	58012000	0.878	11M	0.845	12*
58012012	0.865	11M	0.828	7*	58012100	0.846	15W	0.685		58012112	0.857	15W	0.706		58012200	0.576	UW	*****	23
58012212	0.676	UW	*****	19	58012300	0.695	UW	*****	19	58012312	0.739	UM	*****	5	58012400	0.804	7W	0.791	
58012412	0.648	UW	*****	1	58012500	0.922	17W	0.625		58012512	0.868	17W	0.751		58012600	0.915	5W	0.731	
58012612	0.751	UM	*****	8	58012700	0.781	UW	*****	12	58012712	0.775	UW	*****	1	58012800	0.618	UW	*****	13
58012812	0.954	9W	0.676		58012900	0.886	9W	0.749		58012912	0.771	UM	*****	10	58013000	0.805	12M	0.759	
58013012	0.742	UM	*****	16	58013100	0.842	7M	0.686		58013112	0.887	1W	0.625		58020100	0.754	UM	*****	3
58020112	0.720	UW	*****	19	58020200	0.751	UW	*****	16	58020212	0.856	13W	0.623		58020300	0.823	13M	0.745	
58020312	0.615	UM	*****	24	58020400	0.811	8M	0.638		58020412	0.796	UM	*****	12	58020500	0.726	UM	*****	24
58020512	0.855	1W	0.718		58020600	0.684	UM	*****	4	58020612	0.825	1W	0.714		58020700	0.921	1M	0.844	18
58020712	0.898	1M	0.825	18	58020800	0.616	UM	*****	21	58020812	0.717	UM	*****	8	58020900	0.404	UW	*****	16
58020912	0.838	21W	0.719		58021000	0.783	UM	*****	16	58021012	0.921	7M	0.779		58021100	0.944	10M	0.856	6
58021112	0.854	3W	0.799		58021200	0.834	17M	0.550		58021212	0.638	UM	*****	19	58021300	0.780	UM	*****	10
58021312	0.845	8M	0.747		58021400	0.806	5W	0.764		58021412	0.842	14W	0.679		58021500	0.805	14M	0.803	10*
58021512	0.766	UM	*****	16	58021600	0.842	7M	0.722		58021612	0.848	7M	0.811	5*	58021700	0.839	6M	0.811	6*
58021712	0.876	7M	0.790		58021800	0.936	7M	0.783		58021812	0.868	7M	0.765		58021900	0.746	US	*****	10
58021912	0.773	US	*****	10	58022000	0.839	2M	0.773		58022012	0.859	11M	0.845	7*	58022100	0.863	9W	0.805	7
58022112	0.858	9W	0.842	7*	58022200	0.860	2M	0.841	20*	58022212	0.789	UM	*****	5	58022300	0.850	7M	0.755	
58022312	0.860	10W	0.836	6*	58022400	0.857	10W	0.778		58022412	0.770	UM	*****	18	58022500	0.889	7M	0.730	
58022512	0.869	7S	0.829	5*	58022600	0.724	US	*****	18	58022612	0.783	UM	*****	9	58022700	0.889	14M	0.814	10
58022712	0.870	21W	0.762		58022800	0.787	UW	*****	10	58022812	0.846	9W	0.838	9*	58120100	0.594	UM	*****	10
58120112	0.882	9M	0.666		58120200	0.767	UM	*****	10	58120212	0.797	UM	*****	10	58120300	0.878	13M	0.839	6*
58120312	0.912	1M	0.667		58120400	0.943	1M	0.689		58120412	0.927	1M	0.664		58120500	0.871	1M	0.812	15
58120512	0.889	1M	0.709		58120600	0.844	1M	0.815	8*	58120612	0.807	1M	0.700		58120700	0.854	1M	0.551	
58120712	0.872	3S	0.790		58120800	0.776	US	*****	4	58120812	0.796	US	*****	3	58120900	0.839	1M	0.639	
58120912	0.847	1W	0.691		58121000	0.729	UW	*****	6	58121012	0.803	17W	0.699		58121100	0.792	UW	*****	8
58121112	0.729	UM	*****	8	58121200	0.782	UM	*****	18	58121212	0.902	10M	0.762		58121300	0.903	3W	0.646	

58121312	0.626	UM	*****	8	58121400	0.618	UM	*****	19	58121412	0.922	10S	0.837	6	58121500	0.876	10M	0.868	19•
58121512	0.830	9M	0.795		58121600	0.776	UM	*****	10	58121612	0.874	6M	0.735		58121700	0.924	6M	0.745	
58121712	0.839	6M	0.799		58121800	0.943	2M	0.811	14•	58121812	0.963	2S	0.788		58121900	0.956	2M	0.726	
58121912	0.937	2M	0.747		58122000	0.907	2M	0.794		58122012	0.967	2M	0.732		58122100	0.951	2S	0.825	13
58122112	0.901	12M	0.807	23	58122200	0.916	6M	0.796		58122212	0.873	18W	0.713		58122300	0.896	2W	0.856	2•
58122312	0.922	2M	0.884	2•	58122400	0.927	2M	0.863	2	58122412	0.923	2M	0.798		58122500	0.845	15M	0.711	
58122512	0.839	6W	0.648		58122600	0.780	UW	*****	15	58122612	0.880	1W	0.653		58122700	0.852	1W	0.788	
58122712	0.623	UW	*****	1	58122800	0.694	UM	*****	2	58122812	0.841	5W	0.673		58122900	0.937	14S	0.688	
58122912	0.844	14M	0.732		58123000	0.696	UM	*****	20	58123012	0.730	UM	*****	6	58123100	0.714	UM	*****	6
58123112	0.844	7S	0.769		59010100	0.944	1S	0.634		59010112	0.935	1S	0.613		59010200	0.850	1S	0.570	
59010212	0.786	US	*****	3	59010300	0.825	1S	0.615		59010312	0.932	1S	0.634		59010400	0.947	1S	0.719	
59010412	0.935	1S	0.736		59010500	0.869	1S	0.688		59010512	0.685	UM	*****	20	59010600	0.863	21M	0.815	23•
59010612	0.818	21M	0.754		59010700	0.761	UM	*****	23	59010712	0.756	UM	*****	23	59010800	0.671	UM	*****	11
59010812	0.817	9M	0.745		59010900	0.843	15M	0.759		59010912	0.845	6M	0.823	23•	59011000	0.790	UM	*****	5
59011012	0.822	6W	0.819	6•	59011100	0.857	19M	0.814	5•	59011112	0.809	19W	0.790		59011200	0.816	20W	0.775	
59011212	0.852	7W	0.810	18•	59011300	0.846	7M	0.789		59011312	0.856	13M	0.802	6	59011400	0.867	1M	0.756	
59011412	0.889	3M	0.800	3	59011500	0.847	3W	0.713		59011512	0.754	UW	*****	2	59011600	0.971	2M	0.719	
59011612	0.900	2M	0.789		59011700	0.846	6M	0.792		59011712	0.887	7W	0.807	5	59011800	0.839	7M	0.815	3•
59011812	0.896	1M	0.807	4	59011900	0.893	1S	0.879	8•	59011912	0.906	1S	0.811	4	59012000	0.865	1S	0.846	4•
59012012	0.856	1S	0.786		59012100	0.912	1S	0.612		59012112	0.953	1M	0.745		59012200	0.906	1M	0.849	4
59012212	0.859	3M	0.819	3•	59012300	0.808	1M	0.818	4	59012312	0.925	1M	0.792		59012400	0.923	1M	0.851	18
59012412	0.871	3M	0.831	3•	59012500	0.916	3M	0.754		59012512	0.902	3M	0.730		59012600	0.971	3M	0.733	
59012612	0.898	3M	0.667		59012700	0.951	1W	0.829	18	59012712	0.920	10M	0.832	3	59012800	0.896	10M	0.864	3•
59012812	0.915	1W	0.780		59012900	0.861	1W	0.667		59012912	0.636	UM	*****	1	59013000	0.747	UM	*****	2
59013012	0.750	UM	*****	12	59013100	0.765	UM	*****	12	59013112	0.902	17M	0.764		59020100	0.748	US	*****	8
59020112	0.569	UM	*****	9	59020200	0.605	UM	*****	20	59020212	0.813	1M	0.679		59020300	0.645	UW	*****	9
59020312	0.738	UM	*****	6	59020400	0.950	1M	0.738		59020412	0.962	1M	0.696		59020500	0.879	1W	0.732	
59020512	0.884	10W	0.819	21	59020600	0.919	1M	0.860	18	59020612	0.862	3M	0.795		59020700	0.955	3M	0.806	1
59020712	0.752	UM	*****	1	59020800	0.584	UW	*****	12	59020812	0.670	UW	*****	14	59020900	0.640	UW	*****	23
59020912	0.748	UW	*****	10	59021000	0.816	13W	0.733		59021012	0.654	UM	*****	2	59021100	0.899	5M	0.821	2
59021112	0.941	5M	0.759		59021200	0.871	5W	0.703		59021212	0.877	7M	0.652		59021300	0.817	1M	0.737	
59021312	0.822	4M	0.718		59021400	0.944	4M	0.831	8•	59021412	0.846	17S	0.812	1•	59021500	0.963	4M	0.689	
59021512	0.816	3M	0.759		59021600	0.867	1M	0.686		59021612	0.721	UM	*****	3	59021700	0.639	UM	*****	2
59021712	0.821	8M	0.818	12•	59021800	0.904	5S	0.691		59021812	0.896	5M	0.721		59021900	0.756	US	*****	1
59021912	0.768	UM	*****	1	59022000	0.714	UM	*****	12	59022012	0.654	UM	*****	12	59022100	0.727	UM	*****	12
59022112	0.772	UM	*****	12	59022200	0.674	UW	*****	8	59022212	0.922	14W	0.682		59022300	0.854	11W	0.836	9•
59022312	0.439	UM	*****	4	59022400	0.927	3M	0.658		59022412	0.674	UM	*****	21	59022500	0.583	UM	*****	10
59022512	0.783	UM	*****	10	59022600	0.907	21W	0.773		59022612	0.936	6W	0.691		59022700	0.787	UM	*****	23
59022712	0.523	UW	*****	14	59022800	0.805	14W	0.789		59022812	0.898	14M	0.846	7	59120100	0.540	UM	*****	21
59120112	0.917	2M	0.789		59120200	0.791	UM	*****	20	59120212	0.764	UM	*****	20	59120300	0.745	UM	*****	6
59120312	0.875	1W	0.626		59120400	0.732	UM	*****	22	59120412	0.778	UM	*****	1	59120500	0.864	5W	0.850	9•
59120512	0.572	UM	*****	8	59120600	0.758	UM	*****	16	59120612	0.863	13M	0.731		59120700	0.674	US	*****	3
59120712	0.497	UM	*****	1	59120800	0.513	UM	*****	17	59120812	0.638	UM	*****	6	59120900	0.864	7W	0.667	
59120912	0.914	2M	0.805	10	59121000	0.948	2M	0.834	13	59121012	0.866	14S	0.838	20•	59121100	0.791	UM	*****	20
59121112	0.693	UM	*****	6	59121200	0.915	7M	0.726		59121212	0.935	6M	0.743		59121300	0.849	6W	0.836	17•
59121312	0.603	UW	*****	14	59121400	0.898	14S	0.855	7•	59121412	0.955	12M	0.824	9	59121500	0.603	UM	*****	20
59121512	0.676	UM	*****	18	59121600	0.836	10M	0.728		59121612	0.837	3W	0.656		59121700	0.837	3W	0.469	
59121712	0.805	3W	0.533		59121800	0.865	8M	0.860	7•	59121812	0.946	2S	0.804	9	59121900	0.887	2S	0.856	13•
59121912	0.873	5M	0.854	13•	59122000	0.877	5S	0.841	13•	59122012	0.804	5M	0.669		59122100	0.767	UM	*****	8
59122112	0.776	UM	*****	2	59122200	0.949	5M	0.829	2	59122212	1.000	5M	0.772		59122300	0.989	5M	0.753	
59122312	0.954	5M	0.694		59122400	0.846	5M	0.810	8•	59122412	0.824	17M	0.744		59122500	0.784	UM	*****	10
59122512	0.847	21M	0.815	23•	59122600	0.944	15M	0.763		59122612	0.530	UM	*****	13	59122700	0.806	14M	0.579	
59122712	1.000	14M	0.699		59122800	0.712	UM	*****	20	59122812	0.641	UM	*****	3	59122900	0.661	UM	*****	2
59122912	0.677	UM	*****	7	59123000	0.694	UM	*****	23	59123012	0.534	UM	*****	22	59123100	0.768	UM	*****	3
59123112	0.856	3W	0.794		60010100	0.722	UM	*****	4	60010112	0.636	US	*****	6	60010200	0.942	1M	0.799	
60010212	0.937	3M	0.709		60010300	0.965	3M	0.789		60010312	0.881	3W	0.495		60010400	0.903	1M	0.867	18•
60010412	0.852	3W	0.627		60010500	0.763	UW	*****	8	60010512	0.862	10W	0.846	6•	60010600	0.873	9M	0.834	9•
60010612	0.833	15M	0.828	16•	60010700	0.915	13W	0.635		60010712	0.719	UW	*****	24	60010800	0.799	UM	*****	12
60010812	0.626	UW	*****	12	60010900	0.849	5W	0.728		60010912	0.728	UM	*****	20	60011000	0.784	UM	*****	23
60011012	0.902	6W	0.821	23	60011100	0.878	15M	0.812	5	60011112	0.917	6W	0.794		60011200	0.911	6W	0.840	23

60011212	0.850	2W	0.761	
60011412	0.854	12M	0.837	7•
60011612	0.814	22W	0.508	
60011812	0.928	5M	0.723	
60012012	0.831	10M	0.771	
60012212	0.844	12W	0.689	
60012412	0.962	1M	0.784	
60012612	0.880	1M	0.698	
60012812	0.819	24M	0.752	
60013012	0.843	15W	0.757	
60020112	0.536	UM	*****	19
60020312	0.855	15S	0.801	5
60020512	0.714	UM	*****	5
60020712	0.963	6S	0.741	
60020912	0.779	UM	*****	5
60021112	0.835	2W	0.787	
60021312	0.804	12M	0.774	
60021512	0.952	6M	0.752	
60021712	0.675	UM	*****	2
60021912	0.809	7M	0.806	18•
60022112	0.710	UM	*****	15
60022312	0.941	5M	0.669	
60022512	0.506	UM	*****	18
60022712	0.850	4W	0.746	
60022912	0.597	UM	*****	17
60120412	0.771	UM	*****	11
60120812	0.762	UM	*****	18
60121212	0.711	UM	*****	8
60121612	0.937	3W	0.820	3•
60122012	0.830	3M	0.676	
60122412	0.870	18S	0.750	
60122812	0.556	UW	*****	23
61010112	0.796	UM	*****	19
61010512	0.903	6M	0.825	6
61010912	0.884	6M	0.783	
61011312	0.840	14M	0.814	10•
61011712	0.465	UW	*****	22
61012112	0.813	8W	0.751	
61012512	0.818	4M	0.784	
61012912	0.921	1M	0.665	
61020212	0.869	12W	0.858	15•
61020612	0.556	UM	*****	23
61021012	0.820	13M	0.668	
61021412	0.878	7M	0.763	
61021812	0.662	UW	*****	10
61022212	0.848	9M	0.558	
61022612	0.677	UW	*****	10
61120212	0.670	US	*****	8
61120612	0.664	UM	*****	1
61121012	0.905	8M	0.715	
61121412	0.638	UM	*****	8
61121812	0.819	3M	0.616	
61122212	0.926	9M	0.670	
61122612	0.645	UM	*****	4
61123012	0.798	US	*****	3
62010312	0.802	2M	0.663	
62010712	0.937	1M	0.638	
62011112	0.756	UM	*****	3
62011512	0.546	UM	*****	15
62011912	0.864	4M	0.861	4•

60011300	0.926	2M	0.762	
60011500	0.842	12M	0.827	23•
60011700	0.716	UM	*****	12
60011900	0.798	UM	*****	1
60012100	0.744	UM	*****	7
60012300	0.596	UW	*****	5
60012500	0.871	3M	0.870	3•
60012700	0.885	10M	0.846	3•
60012900	0.902	9S	0.655	
60013100	0.912	2M	0.944	9
60020220	0.866	6M	0.764	
60020400	0.827	2M	0.817	23•
60020600	0.836	18M	0.763	
60020800	0.689	19S	0.878	5•
60021000	0.798	UM	*****	10
60021200	0.912	2W	0.861	13
60021400	0.769	UM	*****	5
60021600	0.923	6M	0.873	17•
60021800	0.650	UM	*****	9
60022000	0.787	UM	*****	18
60022200	0.510	UW	*****	23
60022400	0.729	UM	*****	11
60022600	0.741	UM	*****	2
60022800	0.709	UM	*****	4
60120112	0.857	20M	0.748	
60120512	0.936	2M	0.819	2
60120912	0.969	2M	0.738	
60121312	0.534	UM	*****	21
60121712	0.856	1M	0.794	
60122112	0.881	8S	0.690	
60122512	0.822	8W	0.530	
60122912	0.922	2M	0.718	
61010212	0.939	2S	0.879	9
61010612	0.803	7W	0.771	
61011012	0.819	6M	0.814	6•
61011412	0.852	19M	0.825	5•
61011812	0.693	UW	*****	12
61012212	0.902	8M	0.688	
61012612	0.775	UM	*****	4
61013012	0.872	1W	0.795	
61020312	0.777	UW	*****	3
61020712	0.699	UM	*****	14
61021112	0.928	10M	0.874	3
61021512	0.884	10M	0.780	
61021912	0.832	9M	0.746	
61022312	0.673	UM	*****	2
61022712	0.899	12M	0.765	
61120312	0.874	3M	0.704	
61120712	0.693	UM	*****	17
61121112	0.882	2M	0.890	2•
61121512	0.834	9M	0.778	
61121912	1.000	17M	0.599	
61122312	0.919	7S	0.709	
61122712	0.888	9W	0.760	
61123112	0.926	17M	0.836	
62010412	0.926	8M	0.851	12
62010812	0.753	US	*****	1
62011212	0.851	1M	0.701	
62011612	0.898	3M	0.822	1
62012012	0.815	4M	0.668	

60011312	0.929	2M	0.743	
60011512	0.736	UM	*****	23
60011712	0.944	8S	0.857	12
60011912	0.864	4W	0.434	
60012112	0.783	UM	*****	9
60012312	0.565	UM	*****	3
60012512	0.973	3M	0.700	
60012712	0.824	10W	0.689	
60012912	0.878	9M	0.774	
60013112	0.953	2S	0.828	9
60020212	0.947	6M	0.704	
60020412	0.848	11M	0.683	
60020612	0.839	2M	0.748	
60020812	0.828	6M	0.824	14•
60021012	0.878	14W	0.690	
60021212	0.939	2M	0.847	13
60021412	0.840	12M	0.761	
60021612	1.000	19M	0.753	
60021812	0.723	UM	*****	6
60022012	0.889	14M	0.816	7
60022212	0.671	UW	*****	2
60022412	0.851	1M	0.744	
60022612	0.725	UM	*****	12
60022812	0.790	UM	*****	17
60120212	0.824	12W	0.719	
60120612	0.842	2M	0.841	2•
60121012	0.908	8S	0.847	1
60121412	0.733	US	*****	2
60121812	0.795	UM	*****	17
60122212	0.902	5M	0.591	
60122612	0.837	17M	0.716	
60123012	0.875	6M	0.722	
61010312	0.863	6M	0.637	
61010712	0.858	12W	0.796	
61011112	0.748	UM	*****	5
61011512	0.845	15S	0.830	5•
61011912	0.594	UM	*****	14
61012312	0.899	11M	0.819	7
61012712	0.958	1S	0.801	18
61013112	0.899	8M	0.863	7•
61020412	0.899	14M	0.836	7
61020812	0.851	18M	0.555	
61021212	0.921	7M	0.817	5
61021612	0.658	UM	*****	8
61022012	0.781	UM	*****	10
61022412	0.927	9M	0.822	20•
61022812	0.858	15M	0.804	7
61120412	0.900	17M	0.585	
61120812	0.687	UW	*****	17
61121212	0.850	2M	0.838	2•
61121612	0.831	1M	0.727	
61122012	0.816	11W	0.655	
61122412	0.873	19M	0.739	
61122812	0.951	21S	0.806	20
62010112	0.848	8M	0.707	
62010512	0.914	12M	0.760	
62010912	0.904	5S	0.797	
62011312	0.784	UM	*****	3
62011712	0.769	US	*****	4
62012112	0.841	1S	0.780	

60011400	0.914	2S	0.794	
60011600	0.609	UM	*****	22
60011800	0.961	5S	0.869	2
60012000	0.665	UM	*****	4
60012200	0.911	14M	0.750	
60012400	0.784	UM	*****	3
60012600	0.870	3S	0.632	
60012800	0.770	UM	*****	19
60013000	0.837	9M	0.783	
60020100	0.832	14S	0.830	20•
60020300	0.923	6S	0.793	
60020500	0.554	UW	*****	15
60020700	0.893	6S	0.685	
60020900	0.863	6M	0.768	
60021100	0.788	UM	*****	10
60021300	0.853	12S	0.849	7•
60021500	0.806	2M	0.763	
60021700	0.803	19M	0.545	
60021900	0.793	UM	*****	6
60022100	0.875	12M	0.822	16
60022300	0.847	5M	0.794	
60022500	0.891	1W	0.760	
60022700	0.867	22W	0.592	
60022900	0.872	19M	0.830	15•
60120312	1.000	7M	0.768	
60120712	0.845	17M	0.838	12•
60121112	0.944	5M	0.778	
60121512	0.793	US	*****	1
60121912	1.000	20S	0.760	
60122312	0.850	20S	0.697	
60122712	0.759	UM	*****	4
60123112	0.889	7W	0.807	18
61010412	0.871	6W	0.783	
61010812	0.866	6S	0.903	23
61011212	0.797	UM	*****	5
61011612	0.885	6W	0.777	
61012012	0.901	8M	0.873	7•
61012412	0.845	8M	0.742	
61012812	0.886	1S	0.874	4•
61020112	0.902	2S	0.860	2•
61020512	0.880	2M	0.878	9•
61020912	0.862	14M	0.848	20•
61021312	0.908	6M	0.767	
61021712	0.840	17M	0.569	
61022112	0.923	9M	0.617	
61022512	0.853	7W	0.784	
61120112	0.566	UM	*****	21
61120512	0.811	16M	0.663	
61120912	0.607	US	*****	21
61121312	0.807	5M	0.794	
61121712	0.884	10S	0.821	6•
61122112	0.861	13W	0.695	
61122512	0.929	1W	0.818	18
61122912	0.817	1M	0.770	
62010212	0.916	6S	0.900	17•
62010612	0.974	1S	0.694	
62011012	0.256	UM	*****	17
62011412	0.564	UM	*****	1
62011812	0.786	US	*****	8
62012212	0.918	5M	0.863	2

62012312	0.863	1S	0.787		62012412	0.843	22M	0.678		62012512	0.837	16S	0.816	11•	62012612	0.944	3M	0.676	
62012712	0.933	17M	0.523		62012812	0.781	UM	*****	11	62012912	0.850	3M	0.751		62013012	0.740	UM	*****	8
62013112	0.950	2M	0.729		62020112	0.812	15M	0.811	7•	62020212	0.719	UM	*****	1	62020312	0.878	1M	0.724	
62020412	0.795	UM	*****	6	62020512	0.584	UM	*****	2	62020612	0.809	8M	0.715		62020712	0.864	2M	0.835	2•
62020812	0.901	2W	0.765		62020912	0.839	21W	0.660		62021012	0.847	10W	0.834	6•	62021112	0.929	2M	0.733	
62021212	0.879	15M	0.854	5•	62021312	0.913	6S	0.808	17	62021412	0.906	18S	0.797		62021512	0.910	2M	0.835	13
62021612	0.892	15M	0.739		62021712	0.952	6W	0.802	23	62021812	0.925	19W	0.834	5	62021912	0.721	UW	*****	2
62022012	0.951	8M	0.785		62022112	0.977	2M	0.758		62022212	0.889	16M	0.652		62022312	0.894	4S	0.817	8
62022412	0.866	1M	0.690		62022512	0.738	UM	*****	14	62022612	0.808	8M	0.616		62022712	0.750	UM	*****	12
62022812	0.812	18M	0.673		62120100	0.819	7W	0.747		62120112	0.655	UW	*****	18	62120200	0.745	UW	*****	7
62120212	0.855	9W	0.673		62120300	0.789	UM	*****	23	62120312	0.751	UW	*****	5	62120400	0.563	UW	*****	14
62120412	0.833	5W	0.704		62120500	0.891	2M	0.866	9•	62120512	0.849	11S	0.826	20•	62120600	0.699	UM	*****	20
62120612	0.738	UM	*****	22	62120700	0.647	UM	*****	4	62120712	0.822	1M	0.726		62120800	0.871	1W	0.721	
62120812	0.892	1M	0.819	22	62120900	0.817	16M	0.808	4•	62120912	0.624	UM	*****	21	62121000	0.704	UM	*****	1
62121012	0.892	8S	0.802	12	62121100	0.907	5S	0.858	2•	62121112	0.850	2M	0.839	13•	62121200	0.738	UM	*****	7
62121212	0.880	19M	0.825	5	62121300	0.864	18M	0.813	7	62121312	1.000	2S	0.729		62121400	0.920	2M	0.711	
62121412	0.819	18S	0.756		62121500	0.813	6S	0.782		62121512	0.836	6S	0.816	23•	62121600	0.929	6S	0.841	23
62121612	1.000	6S	0.753		62121700	0.931	6S	0.758		62121712	0.943	6M	0.788		62121800	0.668	6M	0.806	14
62121812	0.868	8M	0.824	7•	62121900	0.900	5M	0.884	2•	62121912	0.956	5M	0.745		62122000	0.874	5M	0.827	8•
62122012	0.613	UM	*****	4	62122100	0.872	1M	0.849	18•	62122112	0.901	1M	0.774		62122200	0.889	3M	0.757	
62122212	1.000	3S	0.642		62122300	0.931	3S	0.753		62122312	0.897	3M	0.819	1	62122400	0.790	US	*****	4
62122412	0.811	4M	0.504		62122500	0.886	4W	0.751		62122512	0.572	UM	*****	8	62122600	0.741	UM	*****	22
62122612	0.905	4W	0.748		62122700	0.765	UM	*****	3	62122712	0.920	1M	0.701		62122800	0.880	1M	0.721	
62122812	0.847	3M	0.771		62122900	0.935	3S	0.699		62122912	0.930	3S	0.655		62123000	0.916	3M	0.749	
62123012	0.888	4M	0.813	8	62123100	0.810	4M	0.795		62123112	0.819	17M	0.819	24•	63010100	0.743	UM	*****	24
63010112	0.697	UW	*****	24	63010200	0.419	UW	*****	14	63010212	0.542	UW	*****	19	63010300	0.755	UM	*****	10
63010312	0.800	UM	*****	23	63010400	0.728	UM	*****	6	63010412	0.750	UM	*****	19	63010500	0.781	US	*****	20
63010512	0.883	6M	0.777		63010600	0.822	7M	0.802	17•	63010612	0.666	UM	*****	19	63010700	0.797	US	*****	5
63010712	0.853	6S	0.707		63010800	0.929	7S	0.801	5	63010812	0.892	7S	0.825	3	63010900	0.965	1S	0.736	
63010912	0.878	1S	0.815	6	63011000	0.752	US	*****	4	63011012	0.857	4M	0.450		63011100	0.793	UM	*****	1
63011112	0.862	5M	0.695		63011200	0.815	3M	0.708		63011212	0.878	3M	0.877	3•	63011300	0.883	20M	0.821	18
63011312	0.920	10M	0.848	3	63011400	0.803	10S	0.756		63011412	0.847	3M	0.781		63011500	0.875	3M	0.766	
63011512	0.853	3M	0.810	3•	63011600	0.925	3M	0.696		63011612	0.810	1W	0.747		63011700	0.901	10M	0.896	3•
63011712	0.882	10M	0.879	3•	63011800	0.812	20S	0.472		63011812	0.783	US	*****	12	63011900	0.746	US	*****	1
63011912	0.830	19M	0.816	15•	63012000	0.851	2M	0.724		63012012	0.811	6S	0.767		63012100	0.919	7M	0.819	5
63012112	0.944	7S	0.848	19	63012200	0.896	1M	0.894	18•	63012212	0.854	20S	0.730		63012300	0.874	20S	0.582	
63012312	0.911	20M	0.534		63012400	0.713	US	*****	21	63012412	0.862	3M	0.786		63012500	0.830	1M	0.701	
63012512	0.703	US	*****	1	63012600	0.947	4M	0.633		63012612	0.878	4M	0.817	8	63012700	0.823	3S	0.577	
63012712	0.927	1S	0.657		63012800	0.862	1M	0.763		63012812	0.818	4M	0.686		63012900	0.895	4M	0.792	
63012912	0.842	4M	0.778		63013000	0.700	UM	*****	1	63013012	0.834	1M	0.543		63013100	0.868	1M	0.796	
63013112	0.901	7M	0.831	18	63020100	0.915	7M	0.911	18•	63020112	0.854	10M	0.759		63020200	0.897	10M	0.805	3
63020212	0.868	10M	0.827	21•	63020300	0.795	UM	*****	21	63020312	0.587	UM	*****	21	63020400	0.572	UM	*****	10
63020412	0.599	UW	*****	8	63020500	0.797	UM	*****	10	63020512	0.888	15M	0.788		63020600	0.748	UM	*****	18
63020612	0.933	2M	0.766		63020700	0.868	15M	0.845	7•	63020712	0.822	15M	0.803	7•	63020800	0.831	2W	0.739	
63020812	0.875	14M	0.812	7	63020900	0.935	14M	0.774		63020912	0.861	14M	0.836	20•	63021000	0.774	UM	*****	20
63021012	0.434	UM	*****	4	63021100	0.881	10M	0.817	3	63021112	0.908	10M	0.881	6•	63021200	0.870	7M	0.807	18
63021212	0.863	6M	0.854	17•	63021300	0.882	6M	0.779		63021312	0.801	2W	0.748		63021400	0.791	UM	*****	20
63021412	0.748	UM	*****	20	63021500	0.761	UM	*****	8	63021512	0.844	7M	0.778		63021600	0.842	10M	0.718	
63021612	1.000	10M	0.781		63021700	0.937	20M	0.722		63021712	0.823	8M	0.583		63021800	0.780	UM	*****	2
63021812	0.572	UM	*****	21	63021900	0.770	UM	*****	21	63021912	0.751	US	*****	14	63022000	0.809	2M	0.722	
63022012	0.856	8M	0.831	7•	63022100	0.828	8S	0.823	7•	63022112	0.847	2M	0.790		63022200	0.924	2M	0.776	
63022212	0.855	18M	0.743		63022300	0.833	8M	0.804	7•	63022312	0.881	2M	0.826	9	63022400	0.849	15M	0.803	20•
63022412	0.844	16W	0.658		63022500	0.665	UM	*****	8	63022512	0.710	UM	*****	19	63022600	0.658	UM	*****	10
63022612	0.782	UM	*****	7	63022700	0.896	2M	0.769		63022712	0.874	8W	0.796		63022800	0.906	5W	0.818	13
63022812	0.810	2W	0.727		63120100	0.594	UW	*****	23	63120112	0.584	UM	*****	21	63120200	0.898	2M	0.801	2
63120212	0.555	UM	*****	12	63120300	0.513	UM	*****	2	63120312	0.810	5M	0.768		63120400	0.847	8M	0.707	
63120412	0.693	US	*****	12	63120500	0.713	UM	*****	12	63120512	0.332	UM	*****	20	63120600	0.779	UM	*****	3
63120612	0.845	1W	0.785		63120700	0.784	UM	*****	3	63120712	0.731	UM	*****	24	63120800	0.783	UM	*****	1
63120812	0.830	4W	0.674		63120900	0.797	UM	*****	1	63120912	0.821	5S	0.734		63121000	0.932	5S	0.651	
63121012	0.838	5M	0.713		63121100	0.786	UM	*****	1	63121112	0.861	1M	0.737		63121200	0.692	US	*****	21

63121212	0.787	8S	*****	2	63121300	0.940	8S	0.831	7	63121312	0.961	5M	0.828	13*	63121400	0.663	11M	0.692	
63121412	0.712	8W	*****	16	63121500	0.826	7W	0.674		63121512	0.889	10M	0.772		63121600	0.795	8M	*****	22
63121612	0.762	8M	*****	4	63121700	0.699	8M	*****	4	63121712	0.852	1M	0.646		63121800	0.939	1M	0.777	
63121812	0.899	10M	0.805	3	63121900	0.858	24M	0.680		63121912	0.812	2M	0.806	2*	63122000	0.926	8M	0.784	
63122012	0.950	8M	0.804	7	63122100	0.950	8M	0.706		63122112	1.000	8M	0.772		63122200	0.946	8M	0.818	12
63122212	0.862	2W	0.703		63122300	0.778	8M	*****	18	63122312	0.966	10M	0.823	3	63122400	0.865	20M	0.847	18*
63122412	0.928	20W	0.872	18	63122500	0.772	8M	*****	10	63122512	0.744	8M	*****	18	63122600	0.769	8M	*****	4
63122612	0.830	20M	0.772		63122700	0.872	20W	0.788		63122712	0.796	8M	*****	2	63122800	0.928	8M	0.640	
63122812	0.981	8M	0.780		63122900	0.935	8M	0.889	12*	63122912	0.970	5M	0.841	2	63123000	0.926	5S	0.862	2
63123012	0.915	5M	0.738		63123100	0.667	8M	*****	4	63123112	0.648	8M	*****	19	64010100	0.665	8M	*****	5
64010112	0.806	12M	0.762		64010200	0.866	6M	0.654		64010212	0.589	8M	*****	15	64010300	0.792	8M	*****	21
64010312	0.875	18W	0.796		64010400	0.868	2W	0.966	2*	64010412	0.840	5W	0.762		64010500	0.877	8W	0.831	12*
64010512	0.903	2M	0.875	9*	64010600	0.924	12M	0.683		64010612	0.739	8M	*****	6	64010700	0.911	1M	0.730	
64010712	0.874	1M	0.676		64010800	0.667	8M	*****	4	64010812	0.867	5M	0.796		64010900	0.855	5M	0.827	2*
64010912	0.888	11M	0.715		64011000	0.862	21M	0.745		64011012	0.762	8M	*****	22	64011100	0.820	4M	0.736	
64011112	0.838	4M	0.790		64011200	0.712	8M	*****	8	64011212	0.795	8M	*****	9	64011300	0.866	2M	0.791	
64011312	0.855	12M	0.795		64011400	0.790	8S	*****	5	64011412	0.829	1M	0.815	6*	64011500	0.844	20M	0.733	
64011512	0.888	2M	0.783		64011600	0.960	2M	0.721		64011612	0.929	2M	0.746		64011700	0.838	6M	0.832	23*
64011712	0.922	6M	0.704		64011800	0.890	7M	0.795		64011812	0.793	8M	*****	11	64011900	0.753	8W	*****	6
64011912	0.757	8W	*****	11	64012000	0.873	13W	0.822	6	64012012	0.800	13M	0.792		64012100	0.769	8M	*****	22
64012112	0.792	8M	*****	1	64012200	0.811	8W	0.807	8*	64012212	0.795	8M	*****	12	64012300	0.823	5M	0.803	8*
64012312	0.769	8M	*****	12	64012400	0.573	8M	*****	12	64012412	0.637	8M	*****	15	64012500	0.491	8M	*****	15
64012512	0.724	8W	*****	17	64012600	0.523	8W	*****	24	64012612	0.858	5W	0.762		64012700	0.931	14M	0.712	
64012712	0.585	8M	*****	6	64012800	0.923	10M	0.840	6	64012812	0.757	8M	*****	10	64012900	0.925	2W	0.748	
64012912	0.937	2M	0.819	13	64013000	0.894	11M	0.811	23	64013012	0.631	8W	*****	23	64013100	0.713	8W	*****	22
64013112	0.671	8W	*****	8	64020100	0.794	8M	*****	10	64020112	0.719	8M	*****	7	64020200	0.950	5M	0.809	2
64020212	0.909	5M	0.665		64020300	0.813	5M	0.606		64020312	0.654	8M	*****		64020400	0.682	8M	*****	1
64020412	0.706	8M	*****	4	64020500	0.828	23M	0.799		64020512	0.594	8M	*****	14	64020600	0.822	8M	0.659	
64020612	0.860	8S	0.850	12*	64020700	0.810	5M	0.796		64020712	0.431	8M	*****	15	64020800	0.883	5M	0.735	
64020812	0.911	5W	0.595		64020900	0.725	8W	*****	8	64020912	0.740	8W	*****	8	64021000	0.895	14M	0.705	
64021012	0.779	8M	*****	6	64021100	0.819	7M	0.812	17*	64021112	0.856	1W	0.665		64021200	0.736	8W	*****	9
64021212	0.840	14M	0.803	20*	64021300	0.864	7M	0.762		64021312	0.822	1M	0.773		64021400	0.815	10M	0.691	
64021412	0.863	9M	0.690		64021500	0.766	8S	*****	10	64021512	0.816	6M	0.787		64021600	0.844	7M	0.842	5*
64021612	0.847	7M	0.825	5*	64021700	0.887	7M	0.806	5	64021712	0.929	7M	0.773		64021800	0.713	8W	*****	19
64021812	0.927	9M	0.768		64021900	0.853	6M	0.710		64021912	0.790	8M	*****	10	64022000	0.850	14M	0.827	7*
64022012	0.763	8M	*****	5	64022100	0.795	8S	*****	14	64022112	0.904	6M	0.680	17*	64022200	0.854	18M	0.673	
64022212	0.904	2M	0.872	2*	64022300	0.816	11M	0.803	7*	64022312	0.750	8M	*****	6	64022400	0.869	23S	0.792	
64022412	0.680	8M	*****	15	64022500	0.531	8W	*****	14	64022512	0.923	8M	0.738		64022600	0.606	8M	*****	9
64022612	0.746	8W	*****	3	64022700	0.824	1W	0.735		64022712	0.829	24W	0.721		64022800	0.740	8M	*****	20
64022812	0.865	6M	0.726		64022900	0.842	7M	0.815	5*	64022912	0.858	7M	0.836	5*	64120100	0.887	4M	0.833	8
64120112	0.851	17M	0.727		64120200	0.910	5M	0.878	2*	64120212	0.901	5S	0.666		64120300	0.744	8M	*****	13
64120312	0.611	8W	*****	20	64120400	0.675	8W	*****	9	64120412	0.813	14M	0.702		64120500	0.832	5M	0.770	
64120512	0.804	5M	0.690		64120600	0.681	14M	0.634		64120612	0.801	14M	0.630		64120700	0.640	8M	*****	19
64120712	0.818	14S	0.728		64120800	0.791	8S	*****	20	64120812	0.717	8M	*****	20	64120900	0.613	8M	*****	3
64120912	0.792	8M	*****	3	64121000	0.815	3M	0.787		64121012	0.849	10S	0.712		64121100	0.784	8S	*****	18
64121112	0.826	16M	0.693		64121200	0.744	8S	*****	18	64121212	0.824	13M	0.767		64121300	0.943	13M	0.832	6
64121312	0.863	13M	0.772		64121400	0.840	1M	0.780		64121412	0.866	1M	0.760		64121500	0.860	1S	0.801	22
64121512	0.806	3S	0.784		64121600	0.892	3S	0.874	1*	64121612	0.883	4S	0.836	4*	64121700	0.879	3M	0.740	
64121712	0.871	3M	0.731		64121800	0.834	1M	0.796		64121812	0.847	3M	0.810	3*	64121900	0.904	3S	0.718	
64121912	0.895	3S	0.763		64122000	0.872	3S	0.782		64122012	0.849	3S	0.744		64122100	0.765	8S	*****	4
64122112	0.955	4S	0.637		64122200	0.732	8S	*****	1	64122212	0.681	8S	*****	22	64122300	0.713	8S	*****	22
64122312	0.688	8S	*****	8	64122400	0.533	8M	*****	4	64122412	0.510	8M	*****	1	64122500	0.492	8M	*****	2
64122512	0.658	8W	*****	11	64122600	0.622	8M	*****	11	64122612	0.643	8M	*****	16	64122700	0.743	8M	*****	22
64122712	0.854	16M	0.802	24	64122800	0.690	8M	*****	11	64122812	0.679	8M	*****	15	64122900	0.776	8M	*****	17
64122912	0.741	8M	*****	3	64123000	0.747	8M	*****	11	64123012	0.668	8M	*****	24	64123100	0.654	8M	*****	2
64123112	0.528	8M	*****	16	65010100	0.856	7M	0.764		65010112	0.872	7M	0.805	11	65010200	0.819	13M	0.803	6*
65010212	0.836	1M	0.746		65010300	0.822	1M	0.801	15*	65010312	0.855	23M	0.721		65010400	0.848	19M	0.813	15*
65010412	0.836	19M	0.763		65010500	0.810	19M	0.766		65010512	0.789	8M	*****	17	65010600	0.783	8M	*****	3
65010612	0.810	23W	0.713		65010700	0.682	1W	0.868	6*	65010712	0.916	1M	0.790		65010800	0.889	3S	0.842	3*
65010812	0.937	3S	0.778		65010900	0.972	3S	0.702		65010912	0.961	3M	0.735		65011000	0.921	3M	0.739	

65011012	0.812	1M	0.726		65011100	0.840	1M	0.824	4*	65011112	0.815	3M	0.801	3*	65011200	0.747	US	*****	21
65011212	0.633	US	*****	2	65011300	0.958	8S	0.837	12	65011312	0.901	5S	0.842	2	65011400	0.941	5M	0.815	13
65011412	0.723	UM	*****	12	65011500	0.821	5W	0.817	8*	65011512	0.870	14M	0.820	12*	65011600	0.713	US	*****	20
65011612	0.876	1M	0.621		65011700	0.749	UM	*****	7	65011712	0.891	5S	0.806	9	65011800	0.555	US	*****	4
65011812	0.826	1M	0.824	21*	65011900	0.765	US	*****	7	65011912	0.943	2M	0.735		65012000	0.777	US	*****	20
65012012	0.909	19S	0.841	5	65012100	0.858	6S	0.842	14*	65012112	0.911	2S	0.734		65012200	0.964	2S	0.760	
65012212	0.896	2M	0.818	20	65012300	0.861	12M	0.706		65012312	0.816	7M	0.752		65012400	0.908	1M	0.848	18
65012412	0.846	1M	0.754		65012500	0.911	1W	0.724		65012512	0.862	7M	0.760		65012600	0.933	1M	0.836	18
65012612	0.863	3M	0.809	22	65012700	0.867	3M	0.820	8*	65012712	0.827	3M	0.785		65012800	0.786	UM	*****	4
65012812	0.574	UW	*****	16	65012900	0.769	UM	*****	23	65012912	0.820	10S	0.783		65013000	0.852	10S	0.782	
65013012	0.766	US	*****	5	65013100	0.857	6M	0.797		65013112	0.812	20M	0.731		65020100	0.843	1W	0.830	18*
65020112	0.944	1M	0.808	18	65020200	0.916	3M	0.869	3*	65020212	0.907	1M	0.856	4	65020300	0.893	3M	0.849	3*
65020312	0.904	3W	0.609		65020400	0.729	UM	*****	6	65020412	0.946	7M	0.764		65020500	0.901	7M	0.785	
65020512	0.808	13M	0.721		65020600	0.823	16M	0.792		65020612	0.695	UM	*****	24	65020700	0.930	2W	0.707	
65020712	0.909	2M	0.776		65020800	0.848	21M	0.806	20*	65020812	0.866	13M	0.798		65020900	0.826	1W	0.698	
65020912	0.630	UW	*****	19	65021000	0.931	9W	0.719		65021012	0.806	9W	0.538		65021100	0.904	2M	0.833	2
65021112	0.866	11M	0.732		65021200	0.634	UW	*****	24	65021212	0.874	14W	0.801	20	65021300	0.756	US	*****	20
65021312	0.836	7S	0.830	5*	65021400	0.832	7S	0.754		65021412	0.834	10S	0.807	3*	65021500	0.754	UM	*****	4
65021512	0.637	UM	*****	18	65021600	0.666	UM	*****	18	65021612	0.668	UM	*****	22	65021700	0.728	UM	*****	22
65021712	0.865	17M	0.678		65021800	0.805	17S	0.782		65021812	0.878	17S	0.758		65021900	0.797	UM	*****	22
65021912	0.887	16M	0.845	11*	65022000	0.780	UM	*****	11	65022012	0.928	1M	0.626		65022100	0.859	3W	0.763	
65022112	0.725	UW	*****	8	65022200	0.800	UM	*****	13	65022212	0.802	2W	0.716		65022300	0.974	2M	0.707	
65022312	0.930	2S	0.716		65022400	0.764	US	*****	5	65022412	0.771	UM	*****	19	65022500	0.805	24S	0.724	
65022512	0.776	US	*****	10	65022600	0.769	US	*****	11	65022612	0.755	UM	*****	18	65022700	0.787	UM	*****	18
65022712	0.816	10M	0.700		65022800	0.699	UM	*****	8	65022812	0.809	5W	0.744		65120100	0.875	18S	0.820	7
65120112	0.797	US	*****	14	65120200	0.905	6M	0.829	14	65120212	0.916	6W	0.846	17	65120300	0.634	UW	*****	1
65120312	0.831	5W	0.769		65120400	0.842	21M	0.776		65120412	0.841	19M	0.769		65120500	0.698	UM	*****	21
65120512	0.893	14M	0.860	7*	65120600	0.762	UM	*****	20	65120612	0.861	19W	0.851	5*	65120700	0.891	15M	0.819	5
65120712	0.881	15W	0.740		65120800	0.864	15M	0.804	5	65120812	0.856	6M	0.828	14*	65120900	0.843	11M	0.707	
65120912	0.913	11M	0.818	12	65121000	0.860	5W	0.710		65121012	0.836	5W	0.767		65121100	0.834	5W	0.656	
65121112	0.904	5W	0.727		65121200	0.682	UW	*****	12	65121212	0.439	UM	*****	5	65121300	0.682	UM	*****	1
65121312	0.846	4M	0.604		65121400	0.884	4M	0.474		65121412	0.842	5M	0.755		65121500	0.807	2M	0.724	
65121512	0.813	2M	0.728		65121600	0.753	US	*****	12	65121612	0.746	US	*****	8	65121700	0.844	17M	0.703	
65121712	0.758	UM	*****	4	65121800	0.748	UM	*****	18	65121812	0.844	21S	0.731		65121900	0.632	UM	*****	15
65121912	0.685	UM	*****	19	65122000	0.654	UM	*****	20	65122012	0.862	7M	0.712		65122100	0.793	UM	*****	6
65122112	0.747	UW	*****	5	65122200	0.744	UM	*****	5	65122212	0.813	9W	0.741		65122300	0.857	21M	0.745	
65122312	0.885	13M	0.838	6*	65122400	0.906	13S	0.739		65122412	0.777	US	*****	11	65122500	0.760	US	*****	15
65122512	0.822	1M	0.771		65122600	0.763	US	*****	15	65122612	0.649	US	*****	1	65122700	0.721	US	*****	1
65122712	0.811	22M	0.756		65122800	0.878	4M	0.750		65122812	0.886	5S	0.727		65122900	0.755	UM	*****	24
65122912	0.845	16M	0.786		65123000	0.907	16M	0.575		65123012	0.875	4W	0.732		65123100	0.740	UM	*****	1
65123112	0.706	UM	*****	12	66010100	0.872	13W	0.675		66010112	0.797	UM	*****	3	66010200	0.924	1M	0.659	
66010212	0.732	UM	*****	3	66010300	0.530	UM	*****	22	66010312	0.624	UM	*****	24	66010400	0.594	UM	*****	24
66010412	0.774	US	*****	24	66010500	0.746	US	*****	2	66010512	0.739	US	*****	12	66010600	0.780	US	*****	12
66010612	0.863	5S	0.743		66010700	0.811	17S	0.783		66010712	0.754	US	*****	1	66010800	0.807	1M	0.708	
66010812	0.841	16M	0.775		66010900	0.910	16M	0.690		66010912	0.827	17S	0.772		66011000	0.810	3M	0.802	1*
66011012	0.884	17M	0.828	1	66011100	0.614	UM	*****	16	66011112	0.862	13M	0.741		66011200	0.733	US	*****	22
66011212	0.878	4M	0.606		66011300	0.810	5M	0.661		66011312	0.810	11M	0.688		66011400	0.762	UM	*****	16
66011412	0.741	UM	*****	6	66011500	0.780	UM	*****	15	66011512	0.765	UM	*****	18	66011600	0.789	UM	*****	10
66011612	0.809	7M	0.782		66011700	0.904	7M	0.750		66011712	0.903	7S	0.757		66011800	0.860	13S	0.727	
66011812	0.796	US	*****	3	66011900	0.768	US	*****	3	66011912	0.809	4M	0.755		66012000	0.439	UW	*****	21
66012012	0.683	UW	*****	2	66012100	0.718	UW	*****	8	66012112	0.836	17M	0.754		66012200	0.921	17M	0.637	
66012212	0.931	17M	0.673		66012300	0.670	UM	*****	2	66012312	0.828	8M	0.604		66012400	0.855	8M	0.820	7*
66012412	0.860	2M	0.664		66012500	0.776	US	*****	5	66012512	0.948	23S	0.778		66012600	0.660	UM	*****	14
66012612	0.829	8M	0.565		66012700	0.935	8M	0.736		66012712	0.911	8M	0.739		66012800	0.864	2M	0.751	
66012812	0.872	2M	0.726		66012900	0.859	2S	0.799		66012912	0.827	15S	0.759		66013000	0.825	15M	0.719	
66013012	0.744	UM	*****	5	66013100	0.753	UM	*****	5	66013112	0.741	UM	*****	5	66020100	0.764	UM	*****	5
66020112	0.637	UM	*****	15	66020200	0.563	UM	*****	14	66020212	0.762	UM	*****	2	66020300	0.718	UM	*****	8
66020312	0.824	17W	0.681		66020400	0.725	UM	*****	8	66020412	0.839	3W	0.676		66020500	0.817	17W	0.648	
66020512	0.626	UM	*****	16	66020600	0.671	UM	*****	22	66020612	0.783	UM	*****	4	66020700	0.762	UM	*****	2
66020712	0.909	11M	0.717		66020800	0.615	UM	*****	13	66020812	0.869	8W	0.698		66020900	0.832	11M	0.825	7*

66020912	0.631	UM	*****	24	66021000	0.443	UW	*****	12	66021012	0.951	14M	0.650		66021100	0.675	US	*****	6
66021112	0.958	1S	0.812	18	66021200	0.788	US	*****	8	66021212	0.824	17W	0.685		66021300	0.798	US	*****	22
66021312	0.874	3M	0.676		66021400	0.807	10M	0.802	3*	66021412	0.918	3M	0.698		66021500	0.760	UM	*****	4
66021512	0.823	20M	0.654		66021600	0.715	UM	*****	19	66021612	0.882	7M	0.743		66021700	0.842	7M	0.737	
66021712	0.841	10W	0.767		66021800	0.724	UW	*****	6	66021812	0.824	12W	0.764		66021900	0.849	15W	0.848	16*
66021912	0.859	2M	0.765		66022000	0.830	2M	0.802	23*	66022012	0.836	15M	0.737		66022100	0.829	15M	0.747	
66022112	0.852	2W	0.771		66022200	0.912	2M	0.814	20	66022212	0.835	2M	0.792		66022300	0.946	2M	0.725	
66022312	0.908	11S	0.752		66022400	0.890	11M	0.705		66022412	0.850	5M	0.778		66022500	0.874	5W	0.709	
66022512	0.862	5M	0.746		66022600	0.811	5M	0.777		66022612	0.723	UM	*****	2	66022700	0.560	UM	*****	20
66022712	0.470	UM	*****	3	66022800	0.832	1M	0.586		66022812	0.928	1M	0.681		66120100	0.862	4S	0.712	
66120112	0.717	US	*****	1	66120200	0.787	UM	*****	22	66120212	0.788	UM	*****	11	66120300	0.818	13S	0.777	
66120312	0.830	16S	0.655		66120400	0.899	4M	0.724		66120412	0.907	4M	0.640		66120500	0.853	16M	0.711	
66120512	1.000	16S	0.703		66120600	0.830	16S	0.824	24*	66120612	0.875	22S	0.699		66120700	0.817	22M	0.650	
66120712	0.901	13M	0.650		66120800	0.920	13M	0.732		66120812	0.906	13M	0.779		66120900	0.716	UW	*****	16
66120912	0.676	UW	*****	24	66121000	0.731	UM	*****	24	66121012	0.708	UM	*****	24	66121100	0.739	US	*****	1
66121112	0.792	UM	*****	1	66121200	0.634	UM	*****	8	66121212	0.648	UM	*****	7	66121300	0.908	2M	0.767	
66121312	0.840	11M	0.828	7*	66121400	0.922	15M	0.703		66121412	0.815	15W	0.738		66121500	0.805	2W	0.803	14*
66121512	0.887	2W	0.773		66121600	0.893	11M	0.862	7*	66121612	0.946	11M	0.719		66121700	0.646	UM	*****	13
66121712	0.854	8M	0.839	12*	66121800	0.815	11M	0.803	7*	66121812	0.747	UM	*****	13	66121900	0.359	UW	*****	24
66121912	0.528	UW	*****	13	66122000	0.748	UM	*****	23	66122012	0.900	15W	0.676		66122100	0.788	UW	*****	23
66122112	0.809	11W	0.681		66122200	0.644	UM	*****	9	66122212	0.573	UM	*****	5	66122300	0.[illegible]53	UW	*****	7
66122312	0.839	11M	0.809	7*	66122400	0.886	2M	0.879	13*	66122412	0.903	11M	0.829	7	66122500	0.857	12M	0.791	
66122512	0.401	UM	*****	11	66122600	0.871	1M	0.828	18*	66122612	0.841	20M	0.626		66122700	0.908	8M	0.808	7
66122712	0.838	11M	0.824	12*	66122800	0.794	UW	*****	12	66122812	0.638	UM	*****	20	66122900	0.835	6M	0.739	
66122912	0.848	18S	0.806	5*	66123000	0.883	2S	0.813	2	66123012	0.920	11S	0.855	7	66123100	0.849	11M	0.624	
66123112	0.873	5M	0.840	13*	67010100	0.878	15W	0.817	13	67010112	0.579	UW	*****	11	67010200	0.723	UW	*****	2
67010212	0.871	8M	0.827	7*	67010300	0.827	12M	0.789		67010312	0.871	6M	0.750		67010400	0.821	6M	0.814	6*
67010412	0.702	UM	*****	10	67010500	0.897	8M	0.738		67010512	0.884	5M	0.868	2*	67010600	0.926	5S	0.747	
67010612	0.953	5M	0.753		67010700	0.953	5M	0.653		67010712	0.897	5M	0.583		67010800	0.810	14M	0.755	
67010812	0.525	UM	*****	3	67010900	0.791	UM	*****	1	67010912	0.853	4W	0.779		67011000	0.796	UM	*****	9
67011012	0.976	2S	0.767		67011100	0.847	2S	0.807	20*	67011112	0.699	US	*****	5	67011200	0.808	19W	0.737	
67011212	0.792	UM	*****	17	67011300	0.764	UW	*****	6	67011312	0.814	1W	0.729		67011400	0.806	1W	0.705	
67011412	0.880	1M	0.761		67011500	0.815	1W	0.813	4*	67011512	0.716	UM	*****	6	67011600	0.486	UM	*****	17
67011612	0.742	UM	*****	2	67011700	0.853	5M	0.710		67011712	0.238	UM	*****	15	67011800	0.691	UM	*****	15
67011812	0.896	8M	0.524		67011900	0.931	8S	0.769		67011912	0.889	2M	0.816	2	67012000	0.765	US	*****	23
67012012	0.849	6S	0.836	23*	67012100	0.819	15M	0.772		67012112	0.637	UM	*****	15	67012200	0.606	UW	*****	15
67012212	0.682	UM	*****	15	67012300	0.853	4W	0.513		67012312	0.927	4M	0.659		67012400	0.818	4S	0.701	
67012412	0.816	4S	0.642		67012500	0.825	4M	0.562		67012512	0.928	4M	0.755		67012600	0.882	4M	0.761	
67012612	0.951	4M	0.721		67012700	0.849	4M	0.633		67012712	0.651	UM	*****	4	67012800	0.681	UM	*****	22
67012812	0.900	16W	0.810	11	67012900	0.881	16M	0.767		67012912	0.849	16W	0.822	24*	67013000	0.733	UM	*****	24
67013012	0.577	UW	*****	24	67013100	0.585	UW	*****	10	67013112	0.809	9M	0.732		67020100	0.705	UM	*****	18
67020112	0.804	9M	0.753		67020200	0.846	2S	0.811	23*	67020212	0.872	6S	0.854	23*	67020300	0.935	6M	0.784	
67020312	0.823	19S	0.786		67020400	0.753	UM	*****	21	67020412	0.775	UM	*****	7	67020500	0.782	UM	*****	8
67020512	0.830	17S	0.758		67020600	0.924	3M	0.549		67020612	0.807	1M	0.763		67020700	0.720	UM	*****	19
67020712	0.773	UM	*****	7	67020800	0.809	2M	0.790		67020812	0.809	12M	0.701		67020900	0.873	7S	0.787	
67020912	0.908	7M	0.812	18	67021000	0.822	7M	0.811	18*	67021012	0.916	3W	0.640		67021100	0.861	17M	0.738	
67021112	0.711	US	*****	8	67021200	0.935	10M	0.803	6	67021212	0.859	7M	0.790		67021300	0.832	7M	0.804	5*
67021312	0.772	UM	*****	5	67021400	0.764	UM	*****	10	67021412	0.827	9M	0.816	7*	67021500	0.930	9S	0.684	
67021512	0.897	9M	0.670		67021600	0.862	9M	0.780		67021612	0.605	UM	*****	11	67021700	0.663	UM	*****	2
67021712	0.913	8W	0.823	12	67021800	0.892	2M	0.819	2	67021812	0.803	8M	0.645		67021900	0.771	UM	*****	2
67021912	0.902	5M	0.871	2*	67022000	0.787	US	*****	12	67022012	0.828	4M	0.696		67022100	0.735	UM	*****	22
67022112	0.744	US	*****	1	67022200	0.489	UM	*****	1	67022212	0.762	US	*****	2	67022300	0.899	5M	0.860	2*
67022312	0.963	5M	0.763		67022400	0.863	5M	0.633		67022412	0.572	UM	*****	16	67022500	0.821	7M	0.767	
67022512	0.870	6M	0.783		67022600	0.863	6M	0.762		67022612	0.841	19M	0.751		67022700	0.882	2W	0.809	14
67022712	0.914	2M	0.870	13*	67022800	0.944	11M	0.825	7	67022812	0.722	UM	*****	20	67120100	0.952	6M	0.801	17
67120112	0.935	6M	0.795		67120200	0.866	19W	0.758		67120212	0.872	2M	0.786		67120300	0.935	2S	0.784	
67120312	0.922	2S	0.783		67120400	0.897	15S	0.812	20	67120412	1.000	15M	0.702		67120500	0.908	15M	0.760	
67120512	0.881	15M	0.726		67120600	0.865	15M	0.682		67120612	0.810	15M	0.788		67120700	0.736	UM	*****	20
67120712	0.614	UM	*****	20	67120800	0.816	11M	0.722		67120812	0.847	2M	0.838	2*	67120900	0.934	5M	0.810	13
67120912	0.903	5M	0.862	13*	67121000	0.716	UM	*****	13	67121012	0.634	UW	*****	20	67121100	0.772	UM	*****	3

67121112	0.943	1M	0.663		67121200	0.934	1M	0.590		67121212	0.878	1M	0.612		67121300	0.523	UN	*****	1
67121312	0.802	8S	0.662		67121400	0.899	5S	0.799		67121412	0.846	5S	0.609		67121500	0.826	5M	0.592	
67121512	0.615	UM	*****	8	67121600	0.601	UM	*****	3	67121612	0.905	1M	0.761		67121700	0.857	1M	0.766	
67121712	0.834	19S	0.790		67121800	0.841	1M	0.772		67121812	0.810	1M	0.720		67121900	0.538	US	*****	15
67121912	0.529	US	*****	1	67122000	0.570	UM	*****	1	67122012	0.589	UM	*****	1	67122100	0.650	UM	*****	1
67122112	0.659	UM	*****	4	67122200	0.817	3W	0.758		67122212	0.919	4M	0.751		67122300	0.928	4S	0.810	8
67122312	0.829	3S	0.815	1*	67122400	0.869	3S	0.752		67122412	0.850	3S	0.840	1*	67122500	0.868	3M	0.792	
67122512	0.730	UM	*****	3	67122600	0.755	UM	*****	3	67122612	0.883	4M	0.591		67122700	0.839	5W	0.778	
67122712	0.493	UM	*****	13	67122800	0.649	UM	*****	24	67122812	0.773	US	*****	3	67122900	0.890	1S	0.869	4*
67122912	0.958	1M	0.800		67123000	0.734	US	*****	21	67123012	0.935	8S	0.829	12	67123100	0.821	2S	0.787	
67123112	0.806	15M	0.731		68010100	0.570	UM	*****	17	68010112	0.420	UM	*****	1	68010200	0.763	UM	*****	2
68010212	0.768	US	*****	14	68010300	0.766	US	*****	7	68010312	0.900	8S	0.779		68010400	0.846	2M	0.724	
68010412	0.740	US	*****	6	68010500	0.595	UM	*****	14	68010512	0.868	8M	0.550		68010600	0.654	UM	*****	2
68010612	0.647	UM	*****	21	68010700	0.846	4W	0.721		68010712	0.673	UM	*****	1	68010800	0.645	UW	*****	11
68010812	0.681	UM	*****	22	68010900	0.469	UM	*****	12	68010912	0.698	UM	*****	7	68011000	0.885	15M	0.731	
68011012	0.831	6M	0.769		68011100	0.857	23S	0.791		68011112	0.660	US	*****	3	68011200	0.476	US	*****	4
68011212	0.576	UM	*****	22	68011300	0.862	16M	0.683		68011312	0.591	UM	*****	2	68011400	0.859	2M	0.731	
68011412	0.904	11M	0.766		68011500	0.648	UW	*****	16	68011512	0.890	13W	0.697		68011600	0.878	13M	0.866	6*
68011612	0.780	UM	*****	6	68011700	0.763	UM	*****	3	68011712	0.839	1M	0.795		68011800	0.622	UM	*****	18
68011812	0.865	21M	0.779		68011900	0.747	UM	*****	17	68011912	0.675	UW	*****	9	68012000	0.625	UW	*****	23
68012012	0.407	UW	*****	1	68012100	0.823	15M	0.652		68012112	0.742	UW	*****	23	68012200	0.467	UW	*****	1
68012212	0.869	14W	0.719		68012300	0.882	12S	0.846	7*	68012312	0.871	6S	0.747		68012400	0.899	18M	0.848	5*
68012412	0.786	UM	*****	17	68012500	0.819	19S	0.802	15*	68012512	0.812	19S	0.784		68012600	0.763	US	*****	15
68012612	0.733	US	*****	2	68012700	0.904	5S	0.728		68012712	0.851	5M	0.728		68012800	0.628	US	*****	8
68012812	0.809	16M	0.674		68012900	0.891	3W	0.779		68012912	0.756	UM	*****	4	68013000	0.883	7M	0.766	
68013012	0.887	10S	0.874	3*	68013100	0.765	US	*****	18	68013112	0.823	16M	0.696		68020100	0.731	UM	*****	24
68020112	0.805	16M	0.648		68020200	0.599	UW	*****	3	68020212	0.704	UM	*****	22	68020300	0.787	UM	*****	11
68020312	0.801	3W	0.645		68020400	0.660	UM	*****	8	68020412	0.841	6M	0.810	23*	68020500	0.835	1W	0.763	
68020512	0.758	UM	*****	19	68020600	0.831	2W	0.750		68020612	0.969	2S	0.805	13	68020700	0.896	6S	0.804	23
68020712	1.000	18S	0.706		68020800	0.953	2S	0.747		68020812	0.826	5S	0.767		68020900	0.920	5M	0.685	
68020912	0.577	UM	*****	12	68021000	0.540	UW	*****	12	68021012	0.468	UW	*****	11	68021100	0.736	UM	*****	7
68021112	0.821	5M	0.692		68021200	0.691	US	*****	8	68021212	0.304	UM	*****	4	68021300	0.365	UW	*****	2
68021312	0.434	UM	*****	8	68021400	0.775	UM	*****	3	68021412	0.828	1W	0.706		68021500	0.811	7M	0.782	
68021512	0.860	7S	0.787		68021600	0.795	US	*****	18	68021612	0.832	24M	0.777		68021700	0.846	24M	0.728	
68021712	0.870	7M	0.774		68021800	0.899	7M	0.892	18*	68021812	0.937	10M	0.811	3	68021900	0.904	10M	0.853	19
68021912	1.000	24M	0.670		68022000	0.790	US	*****	9	68022012	0.891	14S	0.869	7*	68022100	0.857	11S	0.850	20*
68022112	0.817	12M	0.812	10*	68022200	0.840	12M	0.814	7*	68022212	0.843	11M	0.833	7*	68022300	0.859	14M	0.822	20*
68022312	0.689	UM	*****	16	68022400	0.853	7M	0.823	5*	68022412	0.931	6M	0.830	23	68022500	0.887	6W	0.764	
68022512	0.893	7W	0.755		68022600	0.926	6M	0.799		68022612	0.956	18M	0.575		68022700	0.876	8S	0.841	7*
68022712	0.896	5M	0.799		68022800	0.879	5M	0.667		68022812	0.695	UM	*****	12	68022900	0.716	UM	*****	12
68022912	0.549	UM	*****	1	68120100	0.684	UM	*****	17	68120112	0.568	UM	*****	24	68120200	0.769	UM	*****	13
68120212	0.833	11M	0.646		68120300	0.843	21W	0.768		68120312	0.910	13M	0.805	6	68120400	0.829	1M	0.784	
68120412	0.907	1M	0.826	18	68120500	0.746	UM	*****	10	68120512	0.834	9M	0.741		68120600	0.773	UM	*****	5
68120612	0.816	15W	0.803	10*	68120700	0.863	9S	0.861	9*	68120712	0.867	12S	0.778		68120800	0.674	US	*****	16
68120812	0.773	US	*****	22	68120900	0.823	3M	0.770		68120912	0.841	22S	0.769		68121000	0.696	US	*****	22
68121012	0.576	UM	*****	22	68121100	0.678	US	*****	2	68121112	0.877	8M	0.658		68121200	0.766	UM	*****	2
68121212	0.808	5M	0.736		68121300	0.961	5S	0.796		68121312	0.978	5S	0.721		68121400	0.927	5M	0.755	
68121412	0.868	11M	0.791		68121500	0.830	2W	0.742		68121512	0.925	8M	0.828	12	68121600	0.870	5M	0.833	2*
68121612	0.873	5M	0.805	2	68121700	0.919	5M	0.842	2	68121712	0.951	5M	0.698		68121800	0.800	UM	*****	8
68121812	0.866	16M	0.619		68121900	0.723	UM	*****	1	68121912	0.774	UM	*****	1	68122000	0.872	4W	0.539	
68122012	0.467	UM	*****	22	68122100	0.838	1M	0.779		68122112	0.860	1M	0.798		68122200	0.831	23S	0.764	
68122212	0.588	UM	*****	15	68122300	0.673	UM	*****	2	68122312	0.805	4M	0.723		68122400	0.855	4M	0.724	
68122412	0.821	4S	0.794		68122500	0.739	US	*****	4	68122512	0.811	3M	0.770		68122600	0.922	1M	0.694	
68122612	0.943	1M	0.723		68122700	0.895	1M	0.793		68122712	0.926	23M	0.712		68122800	0.902	23M	0.729	
68122812	0.914	23M	0.738		68122900	0.829	23M	0.747		68122912	0.772	UM	*****	15	68123000	0.660	UM	*****	15
68123012	0.642	US	*****	3	68123100	0.709	UM	*****	3	68123112	0.738	UM	*****	3	69010100	0.775	UM	*****	3
69010112	0.664	UM	*****	3	69010200	0.588	UW	*****	21	69010212	0.704	UM	*****	20	69010300	0.852	12M	0.741	
69010312	0.863	9M	0.741		69010400	0.834	12S	0.825	10*	69010412	0.831	6M	0.815	6*	69010500	0.823	1M	0.762	
69010512	0.963	1M	0.704		69010600	0.833	1M	0.829	4*	69010612	0.881	3M	0.711		69010700	0.830	3M	0.725	
69010712	0.840	3M	0.826	3*	69010800	0.852	3M	0.850	3*	69010812	0.840	1M	0.790		69010900	0.875	1M	0.746	

69010912	0.827	3M	0.794	
69011112	0.738	UM	*****	23
69011312	0.912	15M	0.773	
69011512	0.821	23M	0.708	
69011712	0.802	3M	0.794	
69011912	0.823	3M	0.798	
69012112	0.864	4M	0.672	
69012312	0.633	UM	*****	1
69012512	0.623	UM	*****	2
69012712	0.809	4W	0.583	
69012912	0.529	UW	*****	2
69013112	0.972	2S	0.775	
69020212	0.912	2M	0.827	10
69020412	0.792	UM	*****	13
69020612	0.504	UW	*****	19
69020812	0.908	9S	0.755	
69021012	0.547	UW	*****	14
69021212	0.909	11M	0.852	7
69021412	0.822	13M	0.693	
69021612	0.828	14W	0.780	
69021912	0.893	2M	0.890	2*
69022012	0.597	UW	*****	9
69022212	0.787	UM	*****	8
69022412	0.837	11M	0.809	12*
69022612	0.899	5W	0.674	
69022812	0.713	UM	*****	14
69120212	0.657	UM	*****	2
69120412	0.777	UM	*****	17
69120612	0.891	8S	0.826	12
69120812	0.875	5M	0.852	9*
69121012	0.751	UM	*****	7
69121212	0.827	12M	0.817	7*
69121412	0.856	11S	0.840	20*
69121612	0.791	UM	*****	1
69121812	0.784	UM	*****	12
69122012	0.698	UM	*****	13
69122212	0.825	15W	0.807	20*
69122412	0.829	6W	0.658	
69122612	0.880	10M	0.844	3*
69122812	0.908	8M	0.857	12
69123012	0.928	8M	0.847	12
70010112	0.926	5M	0.836	2
70010312	0.754	UM	*****	22
70010512	0.909	1M	0.713	
70010712	0.836	2M	0.711	
70010912	0.891	7M	0.796	
70011112	0.921	1M	0.688	
70011312	0.840	1M	0.672	
70011512	0.855	1M	0.850	4*
70011712	0.608	UM	*****	2
70011912	0.833	2M	0.777	
70012112	0.876	18M	0.782	
70012312	0.903	7M	0.855	18*
70012512	0.879	3W	0.736	
70012712	0.841	10M	0.759	
70012912	0.833	3W	0.610	
70013112	0.840	10M	0.823	6*
70020212	0.874	24S	0.809	21
70020412	0.840	6W	0.735	
70020612	0.790	UM	*****	9
69011000	0.798	UM	*****	4
69011200	0.819	15M	0.691	
69011400	0.880	15M	0.715	
69011600	0.772	UM	*****	3
69011800	0.841	3M	0.750	
69012000	0.731	UM	*****	4
69012200	0.880	4M	0.653	
69012400	0.623	UM	*****	15
69012600	0.700	UM	*****	12
69012800	0.609	UW	*****	1
69013000	0.919	8M	0.736	
69020100	0.920	2S	0.788	
69020300	0.853	9M	0.821	13*
69020500	0.870	21S	0.808	23
69020700	0.772	UW	*****	10
69020908	0.859	15S	0.853	5*
69021100	0.878	2W	0.850	9*
69021300	0.716	UM	*****	13
69021500	0.821	1W	0.688	
69021700	0.919	11M	0.707	
69021900	0.834	5M	0.801	7*
69022100	0.890	2W	0.774	
69022300	0.690	UM	*****	10
69022500	0.878	5W	0.774	
69022700	0.933	5M	0.832	2
69120100	0.751	UM	*****	9
69120300	0.952	2M	0.841	9
69120500	0.863	19M	0.836	15*
69120700	0.933	5S	0.788	
69120900	0.908	14M	0.706	
69121100	0.695	UM	*****	7
69121300	0.908	2W	0.811	13
69121500	0.914	12M	0.716	
69121700	0.799	UM	*****	1
69121900	0.890	8M	0.727	
69122100	0.830	11M	0.775	
69122300	0.900	12M	0.729	
69122500	0.799	UM	*****	19
69122700	0.799	UM	*****	4
69122900	0.926	11M	0.867	7
69123100	0.805	5M	0.661	
70010200	0.709	UM	*****	12
70010400	0.884	1M	0.674	
70010600	0.906	1M	0.775	
70010800	0.917	2M	0.782	
70011000	0.883	13S	0.778	
70011200	0.911	1M	0.684	
70011400	0.880	1M	0.677	
70011600	0.884	3M	0.775	
70011800	0.905	2W	0.828	9
70012000	0.921	2M	0.768	
70012200	0.867	2M	0.745	
70012400	0.948	10M	0.682	
70012600	0.796	UW	*****	8
70012800	0.772	UM	*****	19
70013000	0.893	10M	0.843	3*
70020100	0.889	10S	0.888	6*
70020300	0.789	US	*****	10
70020500	0.776	UW	*****	10
70020700	0.625	UW	*****	20
69011012	0.815	17M	0.761	
69011212	0.836	6M	0.800	23*
69011412	0.797	UM	*****	23
69011612	0.809	1M	0.685	
69011812	0.858	3M	0.821	3*
69012012	0.766	UM	*****	3
69012212	0.803	4W	0.636	
69012412	0.855	23M	0.753	
69012612	0.842	4M	0.769	
69012812	0.625	UW	*****	12
69013012	0.919	8S	0.840	7
69020112	0.931	2M	0.758	
69020312	0.831	21M	0.697	
69020512	0.804	13M	0.737	
69020712	0.852	9M	0.735	
69020912	0.908	6M	0.784	
69021112	0.882	2M	0.857	9*
69021312	0.709	UM	*****	22
69021512	0.933	1W	0.703	
69021712	0.691	UM	*****	12
69021912	0.830	5M	0.639	
69022112	0.875	2M	0.796	
69022312	0.893	2M	0.771	
69022512	0.930	5M	0.723	
69022712	0.931	5M	0.609	
69120112	0.746	US	*****	3
69120312	0.864	2M	0.835	20*
69120512	0.805	18M	0.751	
69120712	0.966	5S	0.791	
69120912	0.802	14M	0.780	
69121112	0.834	2W	0.760	
69121312	0.848	11M	0.833	12*
69121512	0.435	UM	*****	15
69121712	0.846	4W	0.668	
69121912	0.806	8M	0.727	
69122112	0.772	UM	*****	13
69122312	0.814	6S	0.737	
69122512	0.858	24W	0.544	
69122712	0.600	UW	*****	8
69122912	0.724	UM	*****	15
69123112	0.676	UM	*****	1
70010212	0.716	UM	*****	22
70010412	0.951	1M	0.672	
70010612	0.796	UM	*****	21
70010812	0.859	2W	0.796	
70011012	0.815	1S	0.731	
70011212	0.880	1M	0.606	
70011412	0.950	1W	0.730	
70011612	0.861	4W	0.827	4*
70011812	0.885	2M	0.764	
70012012	0.908	2M	0.731	
70012212	0.846	9M	0.776	
70012412	0.861	10M	0.767	
70012612	0.783	UW	*****	4
70012812	0.780	UM	*****	8
70013012	0.845	7M	0.813	18*
70020112	0.854	10S	0.852	21*
70020312	0.796	US	*****	5
70020512	0.826	14W	0.743	
70020712	0.650	UM	*****	18
69011100	0.804	22M	0.645	
69011300	0.869	6M	0.809	23
69011500	0.810	19M	0.782	
69011700	0.881	1M	0.673	
69011900	0.847	3M	0.738	
69012100	0.693	UM	*****	3
69012300	0.829	4W	0.574	
69012500	0.676	US	*****	15
69012700	0.871	4M	0.787	
69012900	0.460	UW	*****	8
69013100	0.965	2S	0.820	2
69020200	0.954	2M	0.718	
69020400	0.745	UM	*****	24
69020600	0.756	UM	*****	5
69020800	0.923	9S	0.664	
69021000	0.838	6W	0.677	
69021200	0.956	2S	0.789	
69021400	0.872	16W	0.705	
69021600	0.743	UW	*****	19
69021800	0.824	8W	0.808	12*
69022000	0.792	UM	*****	8
69022200	0.930	5M	0.721	
69022400	0.914	2M	0.773	
69022600	0.952	5M	0.710	
69022800	0.700	UM	*****	12
69120200	0.812	3M	0.630	
69120400	0.880	12M	0.610	
69120600	0.791	US	*****	2
69120800	0.941	5M	0.771	
69121000	0.820	2W	0.710	
69121200	0.878	2W	0.821	20
69121400	0.902	11M	0.881	7*
69121600	0.696	UM	*****	1
69121800	0.912	4M	0.578	
69122000	0.583	UM	*****	2
69122200	0.849	15M	0.798	
69122400	0.918	6M	0.688	
69122600	0.819	7W	0.705	
69122800	0.891	8M	0.849	7*
69123000	0.726	UM	*****	2
70010100	0.872	5M	0.858	2*
70010300	0.667	UM	*****	1
70010500	0.940	1M	0.674	
70010700	0.747	UM	*****	14
70010900	0.879	9W	0.704	
70011100	0.900	1S	0.668	
70011300	0.848	1M	0.744	
70011500	0.940	1W	0.748	
70011700	0.816	4W	0.747	
70011900	0.788	UM	*****	7
70012100	0.858	18M	0.820	7*
70012300	0.775	UM	*****	6
70012500	0.793	UM	*****	18
70012700	0.944	10W	0.804	21
70012900	0.855	17W	0.597	
70013100	0.879	10S	0.706	
70020300	0.922	20S	0.732	
70020400	0.936	6M	0.705	
70020600	0.780	UM	*****	19
70020800	0.820	2M	0.746	

70020812	0.749	UM	*****	7	70020900	0.336	19M	0.714		70020912	0.881	19W	0.799		70021000	0.695	UW	*****	11
70021012	0.845	7W	0.747		70021100	0.877	6M	0.824	6	70021112	0.788	UM	*****	5	70021200	0.770	UM	*****	7
70021212	0.858	2M	0.811	2*	70021300	0.826	2M	0.764		70021312	0.817	6M	0.693		70021400	0.608	6M	0.754	
70021412	0.810	24M	0.674		70021500	0.787	UM	*****	19	70021512	0.806	9S	0.717		70021600	0.720	US	*****	5
70021612	0.750	US	*****	18	70021700	0.729	UM	*****	10	70021712	0.678	UM	*****	10	70021800	0.732	UM	*****	19
70021812	0.811	20M	0.753		70021900	0.694	UM	*****	19	70021912	0.695	UM	*****	2	70022000	0.763	UW	*****	2
70022012	0.752	UW	*****	12	70022100	0.301	UM	*****	20	70022112	0.894	1W	0.688		70022200	0.888	20W	0.734	
70022212	0.892	2M	0.840	9	70022300	0.956	6W	0.702		70022312	0.853	18M	0.835	5*	70022400	0.816	2M	0.803	2*
70022412	0.931	8S	0.837	12	70022500	0.892	5M	0.820	13	70022512	0.487	UM	*****	1	70022600	0.627	UM	*****	1
70022612	0.828	1M	0.684		70022700	0.943	1M	0.647		70022712	0.944	1M	0.658		70022800	0.814	1M	0.713	
70022812	0.705	UW	*****	7	70120100	0.889	16M	0.669		70120112	0.922	16M	0.749		70120200	0.918	16M	0.732	
70120212	0.945	16M	0.725		70120300	0.966	22M	0.687		70120312	1.000	22M	0.672		70120400	0.853	13M	0.792	
70120412	0.913	16M	0.678		70120500	0.931	4M	0.720		70120512	0.789	UM	*****	12	70120600	0.738	UM	*****	7
70120612	0.865	6M	0.818	23*	70120700	0.985	6M	0.775		70120712	0.939	6M	0.701		70120800	0.767	UM	*****	5
70120812	0.706	UM	*****	10	70120900	0.748	UM	*****	10	70120912	0.622	UM	*****	10	70121000	0.765	UM	*****	19
70121012	0.859	2M	0.828	10*	70121100	0.842	2M	0.777		70121112	0.870	15S	0.844	5*	70121200	0.886	15M	0.695	
70121212	0.877	11M	0.872	7*	70121300	0.837	11M	0.841	7	70121312	0.910	11M	0.846	7	70121400	0.877	11M	0.822	9
70121412	0.833	12M	0.807	9*	70121500	0.900	12M	0.637		70121512	0.733	UM	*****	20	70121600	0.854	7M	0.732	
70121612	0.826	1W	0.797		70121700	0.825	7W	0.769		70121712	0.824	10W	0.805	3*	70121800	0.833	10M	0.827	3*
70121812	0.647	UM	*****	4	70121900	0.685	UM	*****	1	70121912	0.771	UM	*****	2	70122000	0.600	UM	*****	2
70122012	0.734	US	*****	2	70122100	0.902	5M	0.630		70122112	0.680	UM	*****	12	70122200	0.785	UM	*****	2
70122212	0.781	UM	*****	2	70122300	0.565	UM	*****	2	70122312	0.724	UM	*****	15	70122400	0.541	UM	*****	14
70122412	0.914	8S	0.817	7	70122500	0.815	2S	0.796		70122512	0.430	US	*****	15	70122600	0.729	UM	*****	12
70122612	0.875	11S	0.803	12	70122700	0.839	12S	0.848	13*	70122712	0.926	12M	0.821	16	70122800	0.735	UM	*****	20
70122812	0.949	7M	0.746		70122900	0.790	UM	*****	6	70122912	0.867	6M	0.737		70123000	0.837	2M	0.809	14*
70123012	0.906	2M	0.786		70123100	0.874	15M	0.773		70123112	0.854	6M	0.821	23*	71010100	0.771	UW	*****	15
71010112	0.715	UM	*****	3	71010200	0.755	UM	*****	3	71010212	0.838	1M	0.666		71010300	0.811	1M	0.700	
71010312	0.677	UM	*****	2	71010400	0.878	8M	0.695	12*	71010412	0.903	5M	0.792		71010500	0.918	5M	0.705	
71010512	0.861	5M	0.815	2*	71010600	0.944	5M	0.782		71010612	0.550	UM	*****	8	71010700	0.703	UM	*****	11
71010712	0.871	16S	0.782		71010800	0.863	16S	0.684		71010812	0.819	1M	0.727		71010900	0.910	1S	0.830	18
71010912	0.894	1S	0.838	4	71011000	0.879	1S	0.868	4*	71011012	0.905	3S	0.798		71011100	0.879	4S	0.817	4
71011112	0.974	4S	0.753		71011200	0.899	4S	0.826	4	71011212	0.886	3S	0.778		71011300	0.791	US	*****	4
71011312	0.923	1M	0.662		71011400	0.961	1M	0.696		71011412	0.951	1M	0.639		71011500	0.652	UW	*****	6
71011512	0.715	UM	*****	7	71011600	0.803	15S	0.730		71011612	0.853	6S	0.804	23*	71011700	0.712	UM	*****	14
71011712	0.742	UM	*****	17	71011800	0.765	UM	*****	7	71011812	0.967	2S	0.674		71011900	0.913	2S	0.779	
71011912	0.365	US	*****	20	71012000	0.632	US	*****	3	71012012	0.757	US	*****	3	71012100	0.894	1M	0.604	
71012112	0.914	1S	0.646		71012200	0.919	1M	0.619		71012212	0.941	1M	0.676		71012300	0.899	1W	0.800	6
71012312	0.849	1M	0.824	22*	71012400	0.847	16M	0.736		71012412	0.800	17M	0.782		71012500	0.908	16W	0.744	
71012512	0.932	16M	0.634		71012600	0.841	4W	0.740		71012612	0.630	UM	*****	8	71012700	0.870	13M	0.747	
71012712	0.786	UM	*****	22	71012800	0.748	UM	*****	10	71012812	0.648	UM	*****	10	71012900	0.771	UM	*****	17
71012912	0.799	UM	*****	3	71013000	0.772	US	*****	3	71013012	0.816	3M	0.771		71013100	0.840	1M	0.771	
71013112	0.875	1M	0.748		71020100	0.893	20M	0.789		71020112	0.788	UM	*****	10	71020200	0.798	UM	*****	10
71020212	0.745	UM	*****	10	71020300	0.799	UM	*****	18	71020312	0.800	UW	*****	18	71020400	0.859	7W	0.825	18*
71020412	0.844	1W	0.779		71020500	0.841	1W	0.814	15*	71020512	0.617	UM	*****	15	71020600	0.751	UM	*****	2
71020612	0.858	8M	0.808	7	71020700	0.801	5M	0.792		71020712	0.490	UM	*****	23	71020800	0.706	UM	*****	9
71020812	0.483	UM	*****	20	71020900	0.812	7M	0.772		71020912	0.751	US	*****	5	71021000	0.829	6M	0.742	
71021012	0.868	6M	0.765		71021100	0.827	7M	0.717		71021112	0.663	UW	*****	19	71021200	0.930	14M	0.720	
71021212	0.939	14M	0.844	10	71021300	0.890	6M	0.689		71021312	0.789	UM	*****	5	71021400	0.845	6M	0.709	
71021412	0.832	9S	0.815	23*	71021500	0.871	6S	0.859	23*	71021512	0.975	6S	0.736		71021600	0.971	6S	0.816	17
71021612	0.935	6M	0.849	14	71021700	0.829	18M	0.602	5*	71021712	0.877	2W	0.856	13*	71021800	0.870	11W	0.811	12
71021812	0.816	14W	0.815	7*	71021900	0.895	2W	0.736		71021912	0.898	5W	0.730		71022000	0.730	UM	*****	12
71022012	0.633	UM	*****	2	71022100	0.910	2M	0.740		71022112	0.818	2M	0.750		71022200	0.789	UM	*****	7
71022212	0.831	18W	0.759		71022300	0.329	2W	0.817	14*	71022312	0.827	2W	0.810	20*	71022400	0.814	21M	0.810	20*
71022412	0.822	13M	0.812	6*	71022500	0.329	1M	0.737		71022512	0.949	1M	0.701		71022600	0.980	1M	0.729	
71022612	0.956	1M	0.714		71022700	0.846	1W	0.710		71022712	0.720	UM	*****	3	71022800	0.733	UM	*****	4
71022812	0.861	4W	0.590		71120100	0.863	7W	0.713		71120112	0.906	7M	0.669		71120200	0.862	9M	0.797	
71120212	0.843	6S	0.831	23*	71120300	0.884	6M	0.713		71120312	0.643	UM	*****	6	71120400	0.695	US	*****	4
71120412	0.784	US	*****	4	71120500	0.681	10M	0.748		71120512	0.891	10W	0.850	6*	71120600	0.779	UW	*****	18
71120612	0.599	UW	*****	1	71120700	0.779	UW	*****	8	71120712	0.692	UW	*****	9	71120800	0.948	2M	0.816	9
71120812	0.839	12S	0.834	7*	71120900	0.818	6S	0.783		71120912	0.857	7S	0.829	11*	71121000	0.798	US	*****	6

71121012	0.896	1M	0.742	
71121212	0.774	UM	*****	15
71121412	0.833	23S	0.762	
71121612	0.840	5S	0.829	7*
71121812	0.856	4M	0.690	
71122012	0.924	1M	0.731	
71122212	0.805	16M	0.763	
71122412	0.241	US	*****	24
71122612	0.763	US	*****	1
71122812	0.656	UM	*****	2
71123012	0.867	5M	0.652	
72010112	0.736	UM	*****	3
72010312	0.866	3M	0.681	
72010512	0.801	9M	0.731	
72010712	0.846	9M	0.602	
72010912	0.819	7S	0.783	
72011112	0.664	UM	*****	22
72011312	0.965	4M	0.665	
72011512	0.890	14S	0.798	
72011712	0.814	16S	0.764	
72011912	0.833	1S	0.778	
72012112	0.801	3M	0.686	
72012312	0.908	1M	0.624	
72012512	0.940	4M	0.769	
72012712	0.830	4M	0.462	
72012912	0.769	UM	*****	1
72013112	0.907	4M	0.747	
72020212	0.888	1M	0.790	
72020412	0.623	UM	*****	4
72020612	0.912	9M	0.650	
72020812	0.792	UM	*****	16
72021012	0.884	15M	0.862	20*
72021212	0.771	UM	*****	10
72021412	0.839	6M	0.765	
72021612	0.787	US	*****	23
72021812	0.816	4M	0.736	
72022012	0.737	UM	*****	3
72022212	0.791	UM	*****	1
72022412	0.890	1M	0.750	
72022612	0.880	3M	0.735	
72022812	0.817	1M	0.721	
72120112	0.819	1M	0.815	4*
72120312	0.887	4S	0.819	4
72120512	0.858	1M	0.635	
72120712	0.928	4M	0.588	
72120912	0.901	4M	0.859	4*
72121112	0.647	US	*****	1
72121312	0.928	4M	0.673	
72121512	0.746	UM	*****	22
72121712	0.800	6M	0.743	
72121912	0.680	UM	*****	24
72122112	0.869	16M	0.721	
72122312	0.757	UM	*****	8
72122512	0.870	2M	0.805	10
72122712	0.862	2W	0.672	

71121100	0.843	1W	0.781	
71121300	0.477	UM	*****	15
71121500	0.859	23S	0.715	
71121700	0.847	11M	0.641	
71121900	0.784	US	*****	8
71122100	0.840	3M	0.833	3*
71122300	0.832	4M	0.719	
71122500	0.862	4W	0.630	
71122700	0.631	UM	*****	1
71122900	0.890	5M	0.870	2*
71123100	0.264	UM	*****	4
72010200	0.846	16M	0.752	
72010400	0.658	UM	*****	9
72010600	0.863	6S	0.740	
72010800	0.892	9M	0.721	
72011000	0.897	1M	0.739	
72011200	0.687	US	*****	1
72011400	0.904	4M	0.775	
72011600	0.855	7M	0.802	5
72011800	0.843	16S	0.790	
72012000	0.847	3S	0.810	1*
72012200	0.963	3M	0.731	
72012400	0.894	1M	0.667	
72012600	0.936	4S	0.795	
72012800	0.753	UM	*****	1
72013000	0.846	4W	0.600	
72020100	0.862	4M	0.757	
72020300	0.902	1W	0.892	18*
72020500	0.266	UW	*****	15
72020700	0.905	9S	0.776	
72020900	0.689	UM	*****	18
72021100	0.805	7M	0.702	
72021300	0.850	6S	0.748	
72021500	0.938	2M	0.718	
72021700	0.761	US	*****	3
72021900	0.840	4M	0.769	
72022100	0.753	UW	*****	3
72022300	0.914	4M	0.639	
72022500	0.926	1S	0.793	
72022700	0.860	3M	0.648	
72022900	0.834	1M	0.682	
72120200	0.804	3M	0.744	
72120400	0.808	4M	0.697	
72120600	0.681	UM	*****	3
72120800	0.691	UM	*****	1
72121000	0.893	4M	0.678	
72121200	0.788	UM	*****	1
72121400	0.835	4W	0.630	
72121600	0.900	UM	*****	11
72121800	0.892	6M	0.814	23
72122000	0.757	UM	*****	22
72122200	0.951	16M	0.632	
72122400	0.775	UM	*****	9
72122600	0.868	6M	0.802	23
72122800	0.858	2W	0.773	

71121112	0.803	1W	0.793	
71121312	0.885	8M	0.847	7*
71121512	0.619	UM	*****	2
71121712	0.855	16M	0.651	
71121912	0.705	UM	*****	22
71122112	0.907	3M	0.742	
71122312	0.766	US	*****	12
71122512	0.948	4M	0.689	
71122712	0.725	UM	*****	1
71122912	0.906	5M	0.832	2
71123112	0.791	UM	*****	3
72010212	0.786	US	*****	4
72010412	0.868	7M	0.782	
72010612	0.741	UM	*****	6
72010812	0.845	9S	0.840	7*
72011012	0.910	1M	0.778	
72011212	0.748	US	*****	4
72011412	0.941	17M	0.660	
72011612	0.906	7S	0.792	
72011812	0.937	3S	0.706	
72012012	0.909	4S	0.778	
72012212	0.850	3M	0.741	
72012412	0.841	1M	0.778	
72012612	0.866	4S	0.788	
72012812	0.604	8M	*****	22
72013012	0.647	UM	*****	1
72020112	0.863	3M	0.572	
72020312	0.917	1W	0.806	19
72020512	0.680	UW	*****	16
72020712	0.821	9M	0.815	7*
72020912	0.723	UM	*****	14
72021112	0.857	7M	0.816	18*
72021312	0.932	6S	0.775	
72021512	0.940	2S	0.780	
72021712	0.900	3M	0.690	
72021912	0.834	4M	0.798	
72022112	0.746	UM	*****	3
72022312	0.868	4S	0.758	
72022512	0.933	1M	0.763	
72022712	0.845	1M	0.695	
72022912	0.686	UM	*****	18
72120212	0.844	3S	0.786	
72120412	0.802	1M	0.638	
72120612	0.548	UM	*****	1
72120812	0.707	UM	*****	22
72121012	0.611	US	*****	3
72121212	0.853	4M	0.772	
72121412	0.733	UM	*****	4
72121612	0.930	7M	0.767	
72121812	0.809	6W	0.638	
72122012	0.827	4M	0.695	
72122212	0.862	16M	0.729	
72122412	0.738	UM	*****	22
72122612	0.907	6M	0.790	

71121200	0.784	UW	*****	15
71121400	0.797	UM	*****	23
71121600	0.899	8S	0.857	12*
71121800	0.909	4M	0.726	
71122000	0.935	1M	0.712	
71122200	0.819	3M	0.808	3*
71122400	0.809	5M	0.571	
71122600	0.842	4S	0.754	
71122800	0.327	UW	*****	15
71123000	0.945	5M	0.790	
72010100	0.837	1W	0.803	4*
72010300	0.915	3M	0.786	
72010500	0.841	7M	0.760	
72010700	0.839	9M	0.592	
72010900	0.880	12S	0.868	16*
72011100	0.718	UM	*****	3
72011300	0.899	4M	0.730	
72011500	0.842	5M	0.832	8*
72011700	0.822	13S	0.789	
72011900	0.928	3S	0.722	
72012100	0.818	3M	0.794	
72012300	0.826	1S	0.769	
72012500	0.819	3M	0.762	
72012700	0.853	4M	0.579	
72012900	0.860	4W	0.539	
72013100	0.721	UM	*****	1
72020200	0.917	1M	0.734	
72020400	0.838	3W	0.775	
72020600	0.781	UW	*****	10
72020800	0.842	2M	0.836	10*
72021000	0.978	2M	0.749	
72021200	0.873	10M	0.809	6
72021400	0.929	6M	0.711	
72021600	0.940	15S	0.783	
72021800	0.874	3M	0.785	
72022000	0.770	UM	*****	22
72022200	0.677	UM	*****	4
72022400	0.906	3S	0.689	
72022600	0.933	3M	0.839	1
72022800	0.852	1M	0.642	
72120100	0.947	3M	0.753	
72120300	0.863	3S	0.776	
72120500	0.889	1M	0.634	
72120700	0.949	4M	0.452	
72120900	0.755	US	*****	22
72121100	0.884	1M	0.731	
72121300	0.858	4M	0.729	
72121500	0.630	UM	*****	22
72121700	0.825	6M	0.768	
72121900	0.770	UM	*****	10
72122100	0.831	22S	0.817	1*
72122300	0.872	4W	0.818	4
72122500	0.789	UW	*****	7
72122700	0.819	6M	0.741	

APPENDIX 3

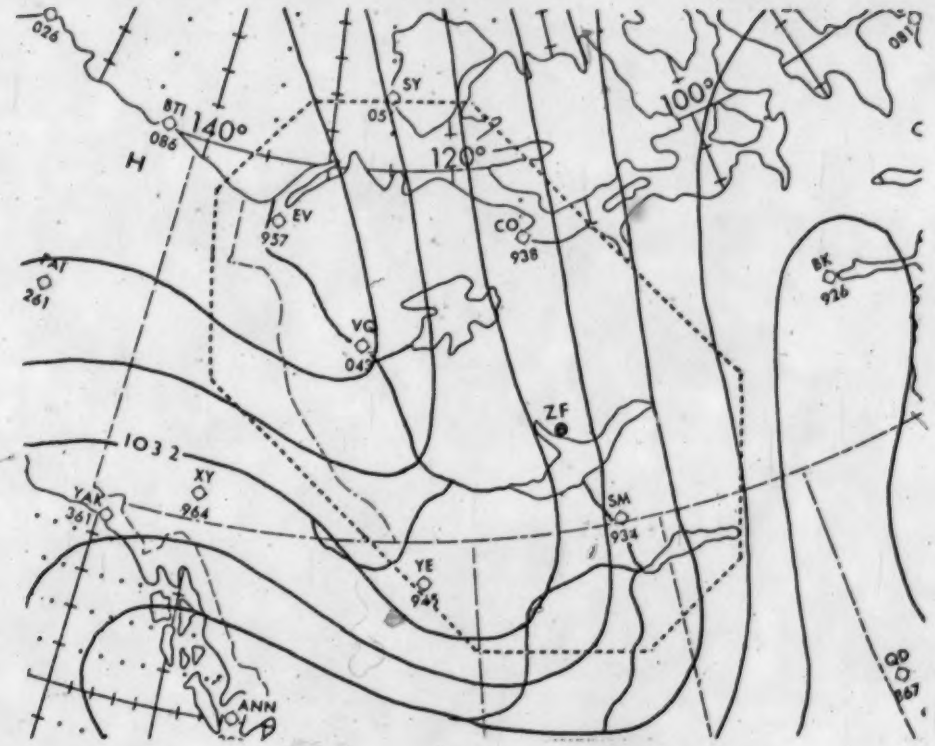
SURFACE MAP TYPES AND CHARACTERISTICS

At the top of each page is an illustration of the isobaric configuration of the key map for a type. The dashed lines form the boundaries of the Mackenzie window. One isobar is labelled and the isobars are drawn at intervals of four millibars.

The characteristics of all maps within a type are summarized by season and month. The months of January and February in 1946, and December, 1972 were not used in the determination of seasonal characteristics. The number of times the map pattern occurred during each period over the 27 years (1946-1972) is listed along with the percentage frequency relative to each period. This is followed by the average of the correlation coefficients resulting from the correlation between the key map and all maps assigned to the type. The mean map pressures listed have been subtracted from 1000 mb. The pressure gradient values are given in units of mb/grid interval (381 km).

Following the gradient information is a list of the types which most frequently follow the given type and the corresponding percentage. Finally, the duration of the map type is indicated by the number of 12-hour periods that the type persisted, and the corresponding percentage.

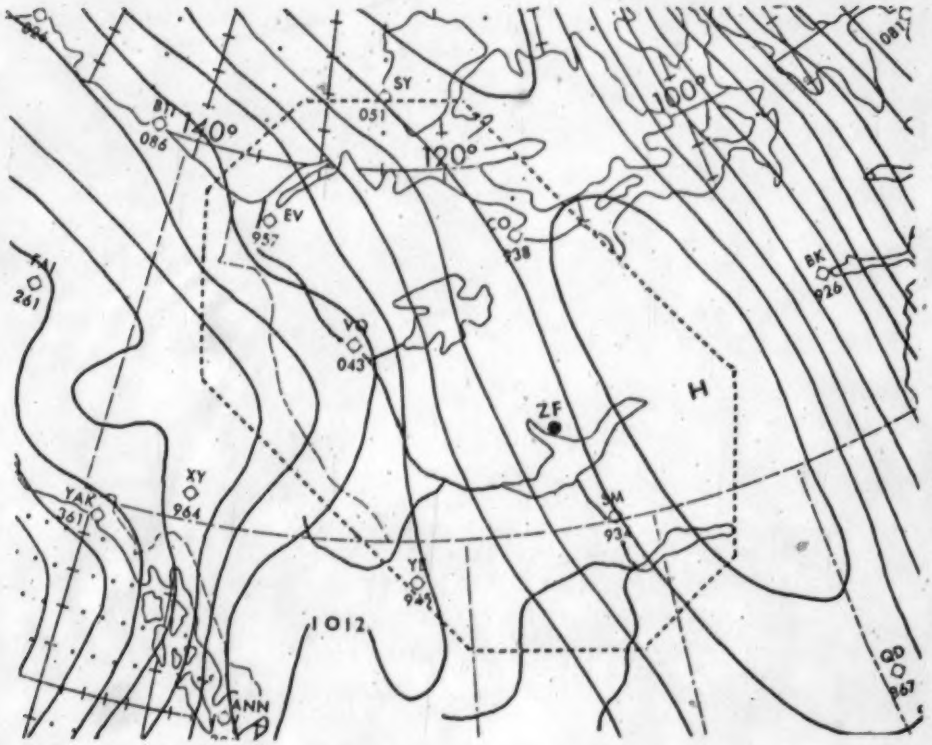
SURFACE MAP TYPE 1



KEY DATE - 12Z, 25 FEB 55

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	343/ 9	94/ 7	167/ 13	92/ 8
MEAN CORRELATION	0.881	0.879	0.881	0.883
MEAN PRESSURE(MSL)	24.42	24.95	25.01	22.83
MEAN PRESSURE GRADIENT	6.01	5.79	6.43	5.49
MEAN MAXIMUM GRADIENT	9.13	8.69	9.85	8.29
MEAN MINIMUM GRADIENT	2.78	2.73	3.00	2.42
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	1/ 51 U/ 21 3/ 14 10/ 4 4/ 2	1/ 51 U/ 21 3/ 15 7/ 3 23/ 3	1/ 57 U/ 17 3/ 16 10/ 4 20/ 3	1/ 46 U/ 30 3/ 10 10/ 5 4/ 3
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 47 2/ 29 3/ 13 4/ 6	2/ 40 1/ 34 3/ 23 8/ 3	1/ 48 2/ 27 3/ 8 4/ 6	1/ 65 2/ 16 3/ 10 4/ 6

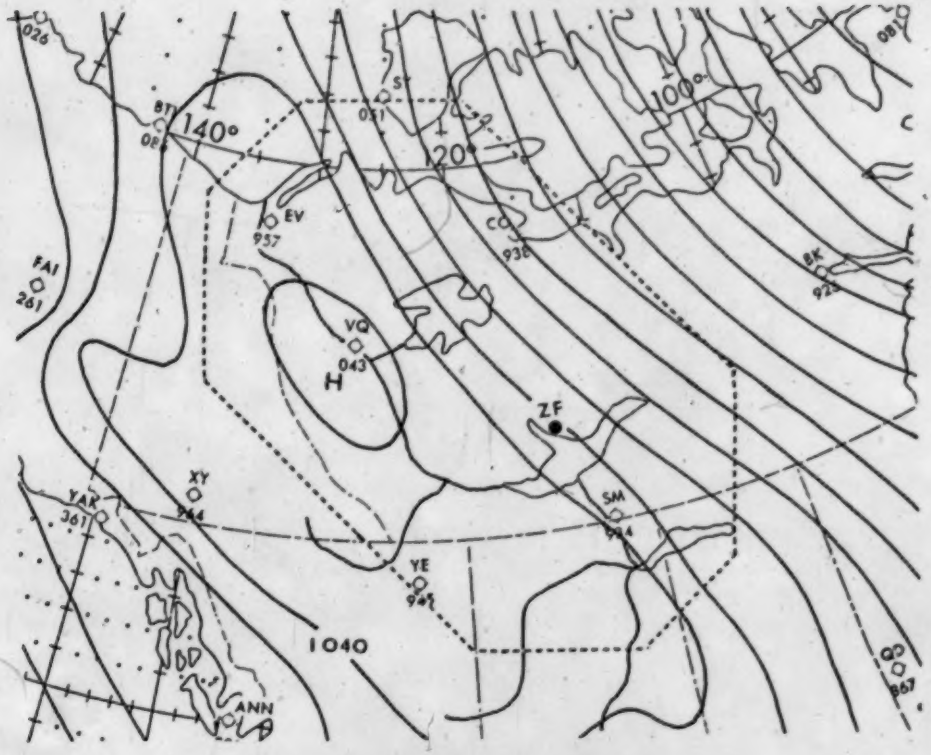
SURFACE MAP TYPE 2



KEY DATE - 12Z, 13 DEC 62

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	253/ 7	97/ 7	72/ 6	93/ 8
MEAN CORRELATION	0.891	0.889	0.897	0.887
MEAN PRESSURE(MSL)	18.30	14.90	19.82	20.68
MEAN PRESSURE GRADIENT	5.89	5.88	6.37	5.52
MEAN MAXIMUM GRADIENT	8.71	8.67	9.42	8.21
MEAN MINIMUM GRADIENT	3.18	3.18	3.42	3.00
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	2/ 42 U/ 12 11/ 11 12/ 9 6/ 6	2/ 42 U/ 14 11/ 13 12/ 9 15/ 6	2/ 47 U/ 17 12/ 11 11/ 8 6/ 6	2/ 34 11/ 13 U/ 10 6/ 9 15/ 7
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 54 2/ 30 3/ 9 4/ 5	1/ 54 2/ 35 4/ 5 3/ 3	1/ 42 2/ 27 3/ 23 4/ 8	1/ 64 2/ 26 3/ 7 4/ 2

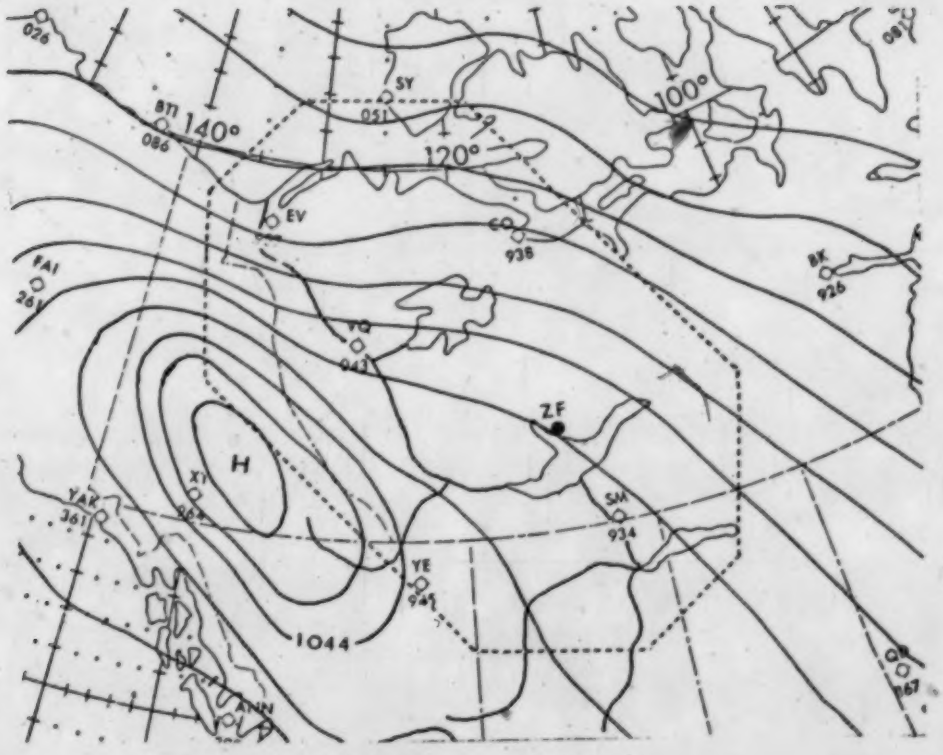
SURFACE MAP TYPE 3



KEY DATE - 12Z, 22 DEC 62

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	197/ 5	63/ 5	102/ 8	39/ 3
MEAN CORRELATION	0.873	0.861	0.876	0.886
MEAN PRESSURE(MSL)	25.28	25.71	25.80	23.26
MEAN PRESSURE GRADIENT	6.61	7.05	6.64	5.85
MEAN MAXIMUM GRADIENT	9.88	10.39	9.93	8.94
MEAN MINIMUM GRADIENT	3.22	3.26	3.31	2.95
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	3/ 47 U/ 20 1/ 18 4/ 7 17/ 3	3/ 52 U/ 21 4/ 8 1/ 8 16/ 4	3/ 53 1/ 20 U/ 15 4/ 8 17/ 1	1/ 30 3/ 26 U/ 26 17/ 11 4/ 4
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 56 2/ 18 3/ 12 4/ 9	1/ 50 3/ 23 4/ 14 2/ 9	1/ 49 2/ 20 3/ 11 4/ 11	1/ 70 2/ 25 3/ 5

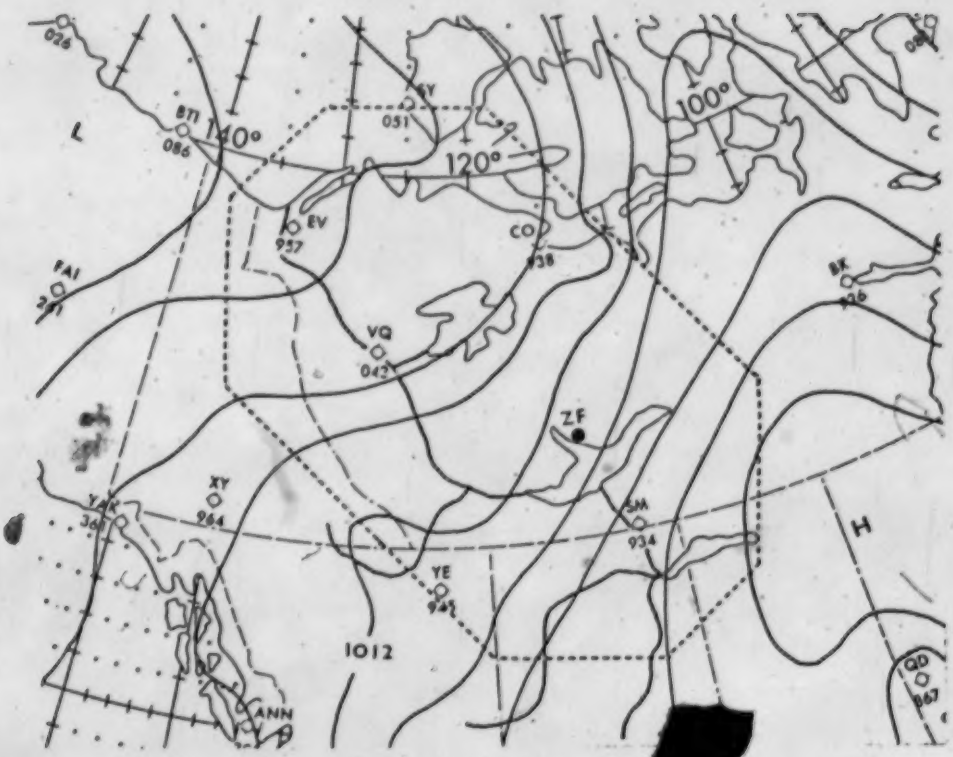
SURFACE MAP TYPE 4



KEY DATE - 12Z, 24 JAN 57

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	190/ 5	69/ 5	98/ 8	35/ 3
MEAN CORRELATION	0.874	0.878	0.871	0.876
MEAN PRESSURE(MSL)	24.63	23.89	25.81	22.78
MEAN PRESSURE GRADIENT	6.07	6.03	6.04	6.24
MEAN MAXIMUM GRADIENT	9.89	10.07	9.72	10.00
MEAN MINIMUM GRADIENT	2.72	2.64	2.76	2.77
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	4/ 49 U/ 29 3/ 9 17/ 6 5/ 6	4/ 44 U/ 32 5/ 9 3/ 5 17/ 4	4/ 54 U/ 29 3/ 7 17/ 6 5/ 3	4/ 45 U/ 25 3/ 20 17/ 5 5/ 5
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 48 2/ 28 3/ 16 5/ 3	1/ 48 2/ 34 3/ 10 4/ 3	1/ 52 2/ 19 3/ 19 4/ 3	1/ 44 2/ 33 3/ 22

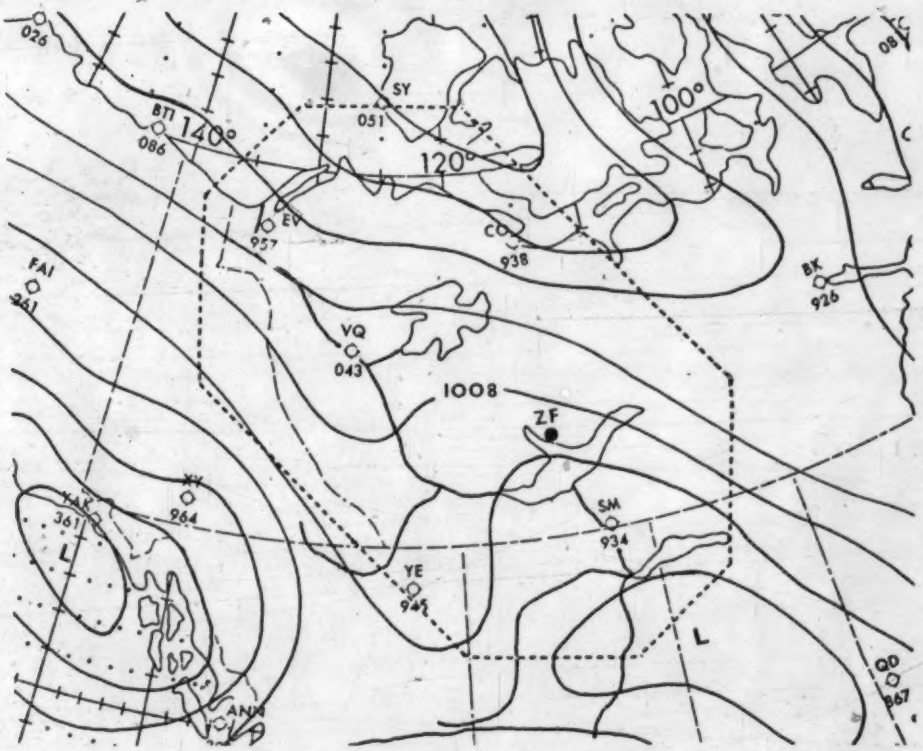
SURFACE MAP TYPE 5



KEY DATE - 12Z, 22 DEC

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	188/ 5	83/ 6	55/ 4	51/ 4
MEAN CORRELATION	0.883	0.882	0.888	0.882
MEAN PRESSURE (MSL)	15.39	12.69	19.89	14.94
MEAN PRESSURE GRADIENT	5.20	5.29	5.50	4.73
MEAN MAXIMUM GRADIENT	8.21	8.40	8.22	7.87
MEAN MINIMUM GRADIENT	2.45	2.50	2.93	1.84
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	5/ 45 U/ 33 14/ 6 2/ 4 11/ 4	5/ 49 U/ 28 2/ 6 11/ 6 14/ 5	5/ 36 U/ 30 14/ 12 17/ 6 11/ 6	5/ 48 U/ 45 14/ 5 7/ 2
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 58 2/ 18 3/ 10 4/ 9	1/ 56 3/ 16 4/ 16 2/ 9	1/ 70 2/ 20 4/ 5 5/ 5	1/ 48 2/ 29 3/ 14 4/ 5

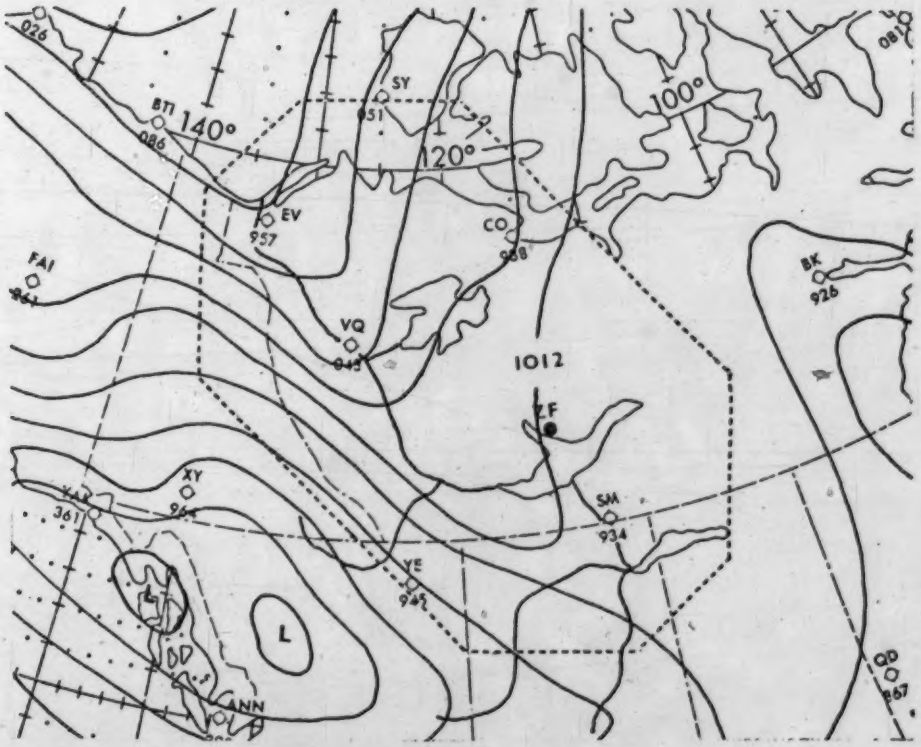
SURFACE MAP TYPE 6



KEY DATE - 12Z, 16 DEC 62

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	169/ 5	69/ 5	48/ 4	69/ 6
MEAN CORRELATION	0.877	0.880	0.867	0.881
MEAN PRESSURE(MSL)	15.22	12.10	15.34	18.27
MEAN PRESSURE GRADIENT	5.29	5.25	5.29	5.32
MEAN MAXIMUM GRADIENT	8.08	7.87	7.96	8.38
MEAN MINIMUM GRADIENT	2.55	2.66	2.46	2.49
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	6/ 38 U/ 19 7/ 9 18/ 8 19/ 7	6/ 53 U/ 16 2/ 8 19/ 8 18/ 6	U/ 28 7/ 20 6/ 16 15/ 12 2/ 8	6/ 40 U/ 17 18/ 13 7/ 10 19/ 6
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 59 2/ 28 3/ 8 4/ 3	1/ 38 3/ 29 2/ 24 4/ 5	1/ 81 2/ 19	1/ 52 2/ 38 4/ 7 3/ 3

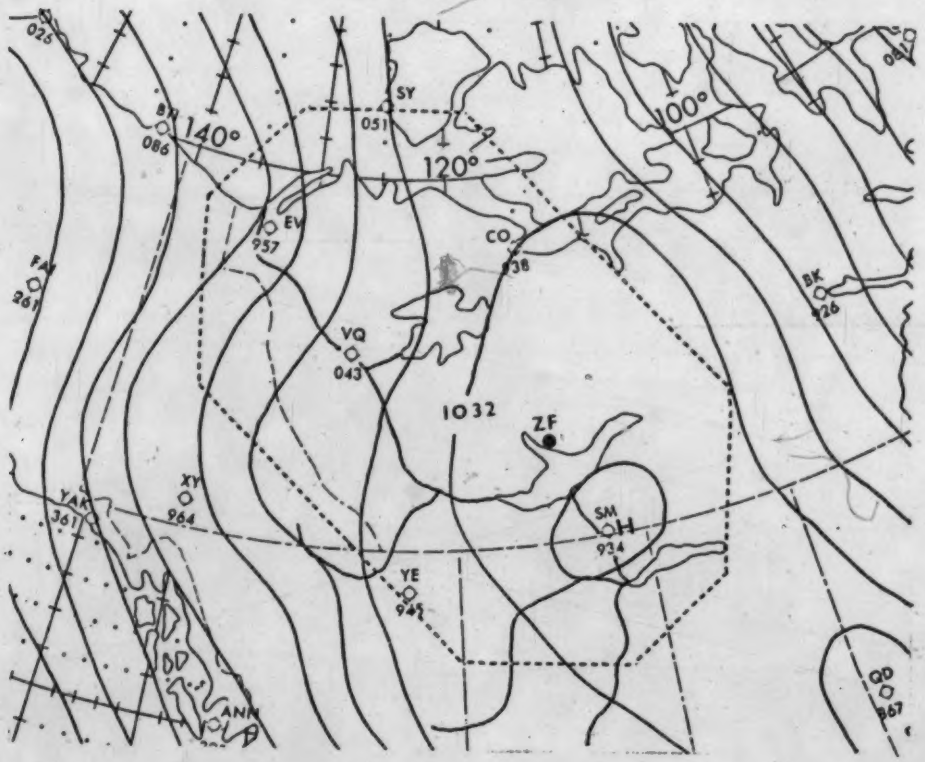
SURFACE MAP TYPE 7



KEY DATE - 12Z, 3 DEC 60

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	154/ 4	34/ 3	56/ 4	66/ 6
MEAN CORRELATION	0.867	0.868	0.867	0.867
MEAN PRESSURE(MSL)	18.79	16.41	17.77	20.87
MEAN PRESSURE GRADIENT	4.81	4.52	5.00	4.80
MEAN MAXIMUM GRADIENT	7.23	6.97	7.49	7.14
MEAN MINIMUM GRADIENT	2.17	1.97	2.17	2.28
MOST FREQUENTLY	7/ 33	U/ 37	7/ 37	7/ 35
FOLLOWING MAP TYPE	U/ 18	10/ 21	1/ 17	10/ 19
(MAP TYPE/FREQUENCY)	10/ 16	1/ 11	U/ 17	U/ 17
	1/ 14	6/ 11	13/ 14	1/ 12
	6/ 8	7/ 11	10/ 9	6/ 12
MOST FREQUENT DURATION	1/ 60	1/ 92	1/ 53	1/ 55
(NUMBER OF 12-HOUR	2/ 33	2/ 8	2/ 42	2/ 35
PERIODS/FREQUENCY)	3/ 6		3/ 5	3/ 6
	4/ 1			4/ 3

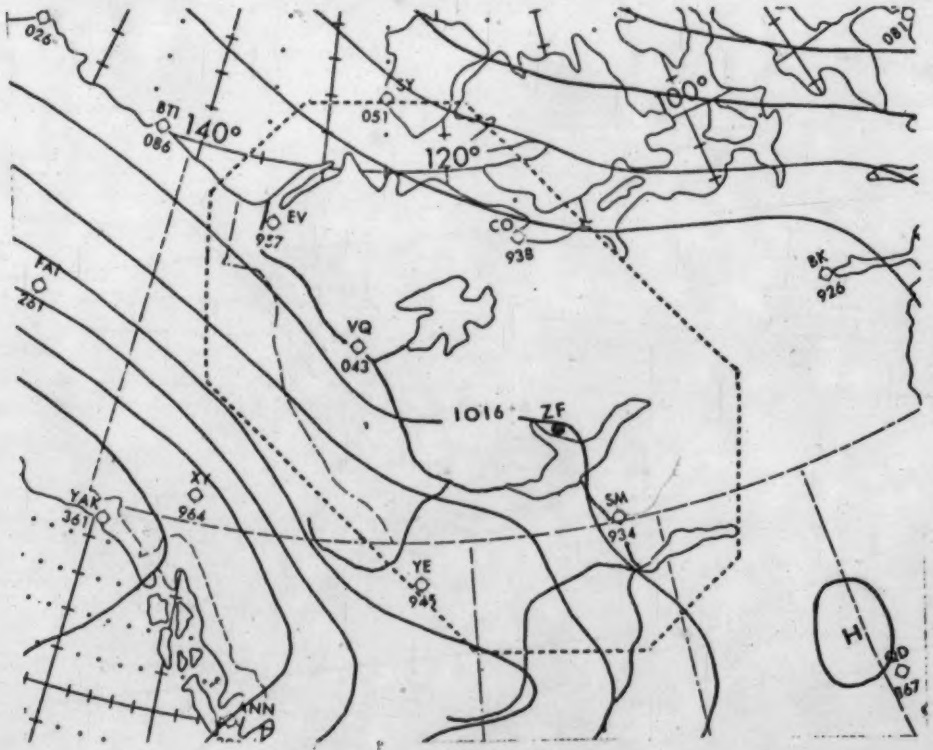
SURFACE MAP TYPE 8



KEY DATE - 12Z, 21 DEC 63

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	99/ 3	43/ 3	32/ 2	28/ 2
MEAN CORRELATION	0.883	0.899	0.881	0.859
MEAN PRESSURE(MSL)	24.05	22.05	25.69	25.23
MEAN PRESSURE GRADIENT	4.81	4.95	4.88	4.52
MEAN MAXIMUM GRADIENT	8.17	8.20	8.52	7.71
MEAN MINIMUM GRADIENT	1.71	1.75	1.80	1.55
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	5/ 31 8/ 23 2/ 23 U/ 14 11/ 6	5/ 31 8/ 28 2/ 17 U/ 14 11/ 10	2/ 35 8/ 29 5/ 24 12/ 6 U/ 6	5/ 39 2/ 22 U/ 22 8/ 11 11/ 6
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 80 2/ 14 3/ 4 5/ 2	1/ 81 2/ 10 3/ 5 5/ 5	1/ 67 2/ 25 3/ 8	1/ 88 2/ 13

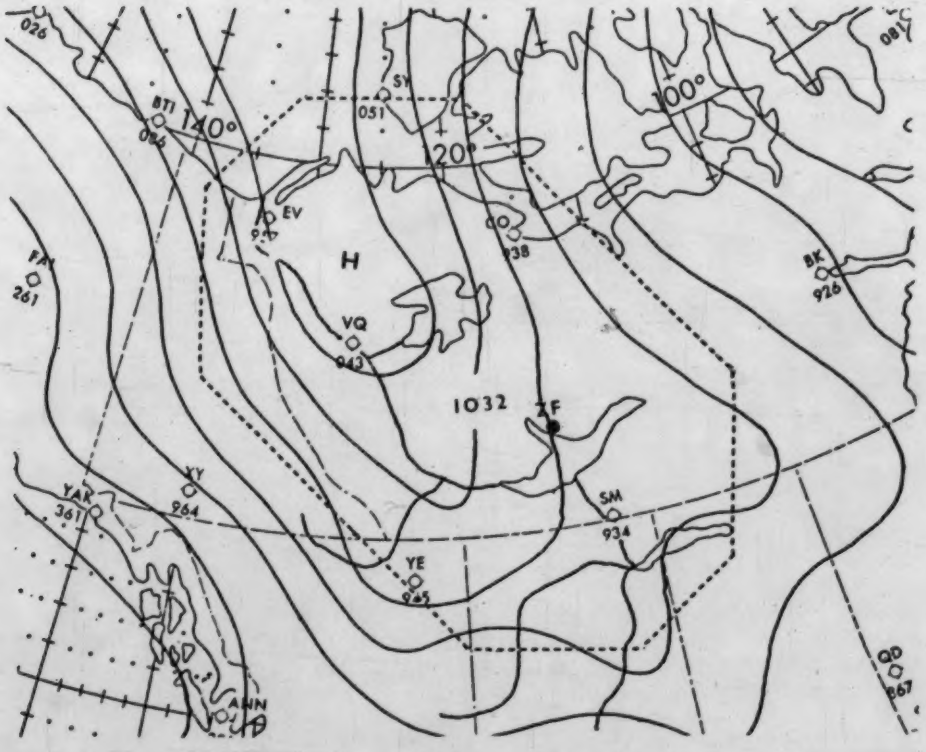
SURFACE MAP TYPE 9



KEY DATE - 12Z, 19 DEC 56

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	86/ 2	24/ 2	26/ 2	39/ 3
MEAN CORRELATION	0.859	0.853	0.857	0.864
MEAN PRESSURE(MSL)	19.28	18.22	17.98	20.78
MEAN PRESSURE GRADIENT	4.40	4.36	4.15	4.59
MEAN MAXIMUM GRADIENT	7.59	7.34	7.11	8.06
MEAN MINIMUM GRADIENT	1.24	1.27	1.21	1.24
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	9/ 30 U/ 23 6/ 12 2/ 8 21/ 8	U/ 50 6/ 19 9/ 13 2/ 6 21/ 6	9/ 33 12/ 17 15/ 17 U/ 17 7/ 11	9/ 38 2/ 15 U/ 15 6/ 12 21/ 12
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 74 2/ 14 3/ 7 4/ 5	1/ 86 2/ 14	1/ 70 2/ 10 3/ 10 4/ 10	1/ 60 2/ 20 3/ 13 4/ 7

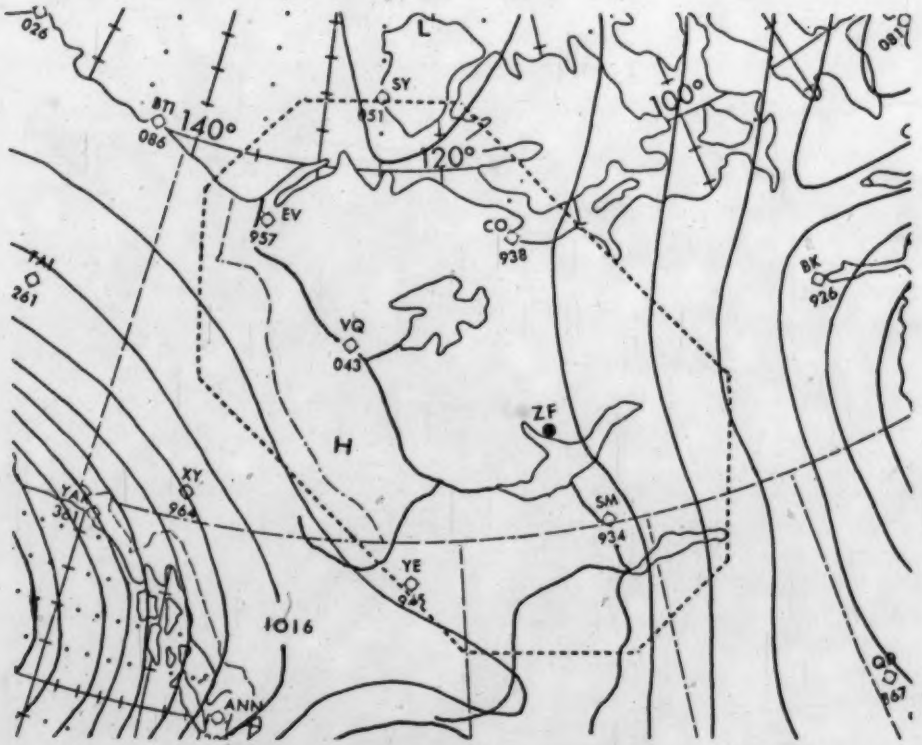
SURFACE MAP TYPE 10



KEY DATE - 12Z, 16 FEB 63

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	86/ 2	24/ 2	26/ 2	37/ 3
MEAN CORRELATION	0.869	0.863	0.869	0.874
MEAN PRESSURE(MSL)	21.47	22.24	18.00	23.41
MEAN PRESSURE GRADIENT	4.55	4.41	4.63	4.58
MEAN MAXIMUM GRADIENT	7.30	7.17	7.62	7.16
MEAN MINIMUM GRADIENT	2.06	2.09	2.14	1.99
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 31 10/ 30 3/ 8 9/ 8 1/ 6	U/ 38 10/ 19 3/ 13 9/ 13 1/ 6	U/ 40 10/ 30 1/ 5 3/ 5 7/ 5	10/ 30 U/ 26 7/ 11 1/ 7 3/ 7
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 64 2/ 31 3/ 2 4/ 2	1/ 77 2/ 23	1/ 54 2/ 46	1/ 67 2/ 28 3/ 6

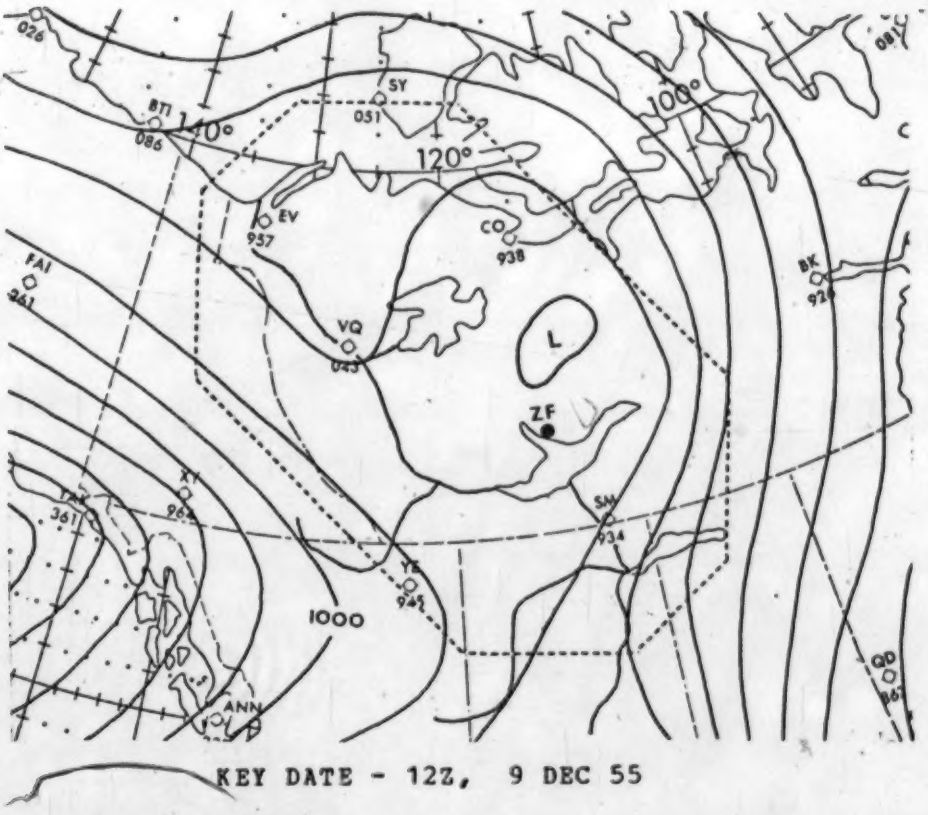
SURFACE MAP TYPE 11



KEY DATE - 12Z, 30 DEC 57

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	76/ 2	42/ 3	13/ 1	22/ 2
MEAN CORRELATION	0.874	0.870	0.883	0.875
MEAN PRESSURE(MSL)	14.16	12.90	16.70	15.07
MEAN PRESSURE GRADIENT	4.62	4.68	5.19	4.17
MEAN MAXIMUM GRADIENT	8.15	8.42	8.95	7.16
MEAN MINIMUM GRADIENT	1.78	1.85	1.76	1.66
MOST FREQUENTLY.	U/ 38	11/ 34	U/ 44	U/ 53
FOLLOWING MAP TYPE	11/ 26	U/ 29	11/ 33	14/ 13
(MAP TYPE/FREQUENCY)	5/ 8	12/ 11	21/ 11	5/ 13
	12/ 8	2/ 9	15/ 11	9/ 7
	2/ 5	5/ 6		11/ 7
MOST FREQUENT DURATION	1/ 80	1/ 78	1/ 67	1/ 93
(NUMBER OF 12-HOUR	2/ 11	2/ 9	2/ 17	2/ 7
PERIODS/FREQUENCY)	3/ 4	3/ 4	3/ 17	
	4/ 2	4/ 4		

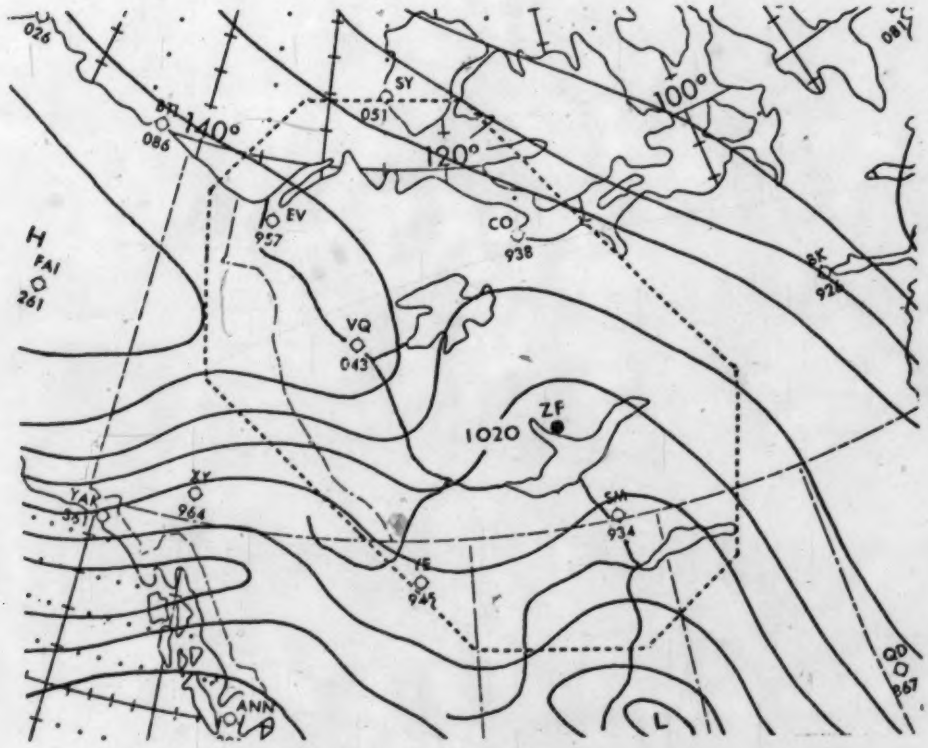
SURFACE MAP TYPE 12



KEY DATE - 12Z, 9 DEC 55

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	71/ 2	26/ 2	26/ 2	20/ 2
MEAN CORRELATION	0.866	0.883	0.859	0.854
MEAN PRESSURE(MSL)	11.71	8.92	12.27	14.62
MEAN PRESSURE GRADIENT	5.18	5.26	5.21	5.04
MEAN MAXIMUM GRADIENT	8.85	9.29	8.51	8.70
MEAN MINIMUM GRADIENT	2.41	2.26	2.50	2.48
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 43 12/ 22 6/ 15 7/ 9 2/ 4	U/ 45 6/ 20 12/ 20 1/ 5 7/ 5	U/ 48 6/ 19 12/ 19 7/ 10 9/ 5	U/ 38 12/ 23 7/ 15 2/ 8 11/ 8
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 76 2/ 19 3/ 5	1/ 77 2/ 15 3/ 8	1/ 81 2/ 13 3/ 6	1/ 70 2/ 30

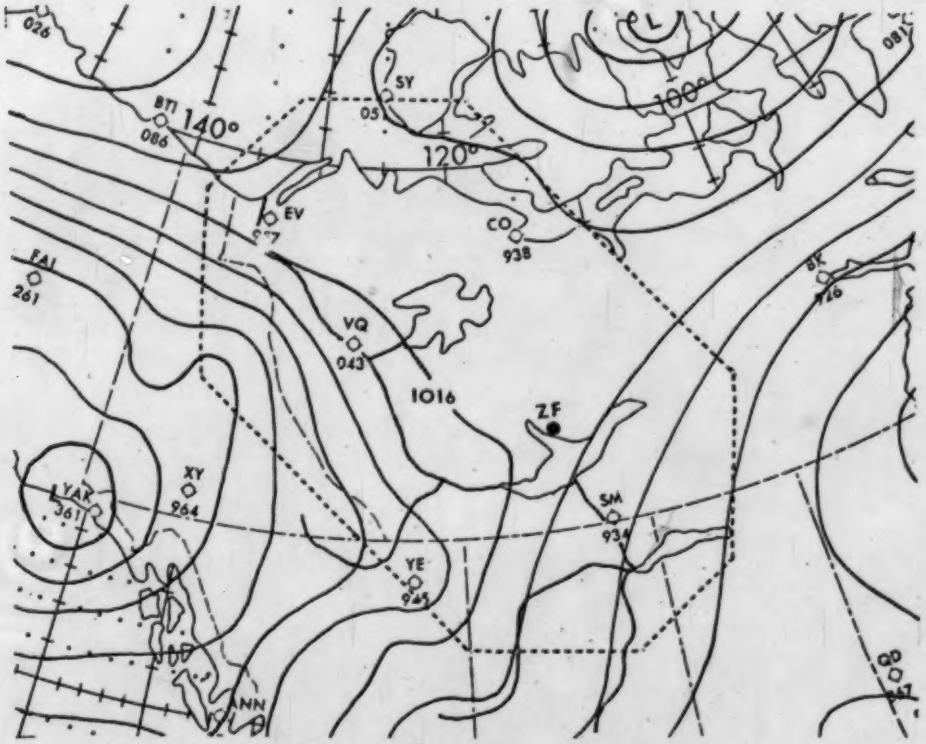
SURFACE MAP TYPE 13



KEY DATE - 12Z, 10 FEB 56

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	70/ 2	21/ 2	24/ 2	25/ 2
MEAN CORRELATION	0.862	0.877	0.856	0.854
MEAN PRESSURE(MSL)	21.09	21.91	20.62	20.84
MEAN PRESSURE GRADIENT	4.70	4.58	4.63	4.86
MEAN MAXIMUM GRADIENT	7.52	7.41	6.99	8.11
MEAN MINIMUM GRADIENT	2.06	1.99	2.17	2.01
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 38 13/ 27 1/ 22 16/ 11 19/ 2	13/ 36 U/ 29 1/ 21 16/ 14	U/ 47 13/ 24 1/ 18 19/ 6 16/ 6	U/ 36 1/ 29 13/ 21 16/ 14
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 70 2/ 24 3/ 6	1/ 67 3/ 22 2/ 11	1/ 67 2/ 33	1/ 73 2/ 27

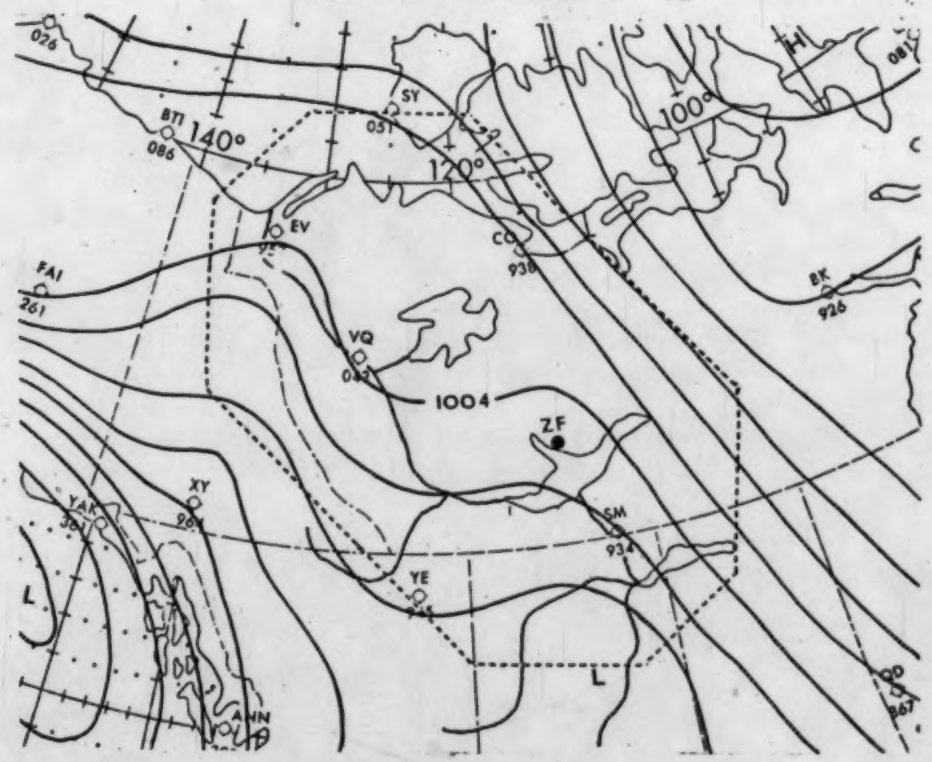
SURFACE MAP TYPE 14



KEY DATE - 12Z, 27 DEC 59

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	64/ 2	20/ 2	12/ 1	32/ 3
MEAN CORRELATION	0.867	0.860	0.870	0.870
MEAN PRESSURE(MSL)	14.43	12.58	16.38	14.85
MEAN PRESSURE GRADIENT	4.31	4.66	4.06	4.17
MEAN MAXIMUM GRADIENT	7.45	8.71	7.15	6.78
MEAN MINIMUM GRADIENT	1.54	1.67	1.05	1.65
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 40 14/ 21 12/ 15 7/ 6 11/ 6	U/ 46 14/ 31 2/ 8 5/ 8 12/ 8	12/ 38 U/ 38 7/ 13 14/ 13	U/ 38 14/ 19 11/ 12 7/ 8 12/ 8
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 79 2/ 18 3/ 3	1/ 56 2/ 44	1/ 86 2/ 14	1/ 85 2/ 10 3/ 5

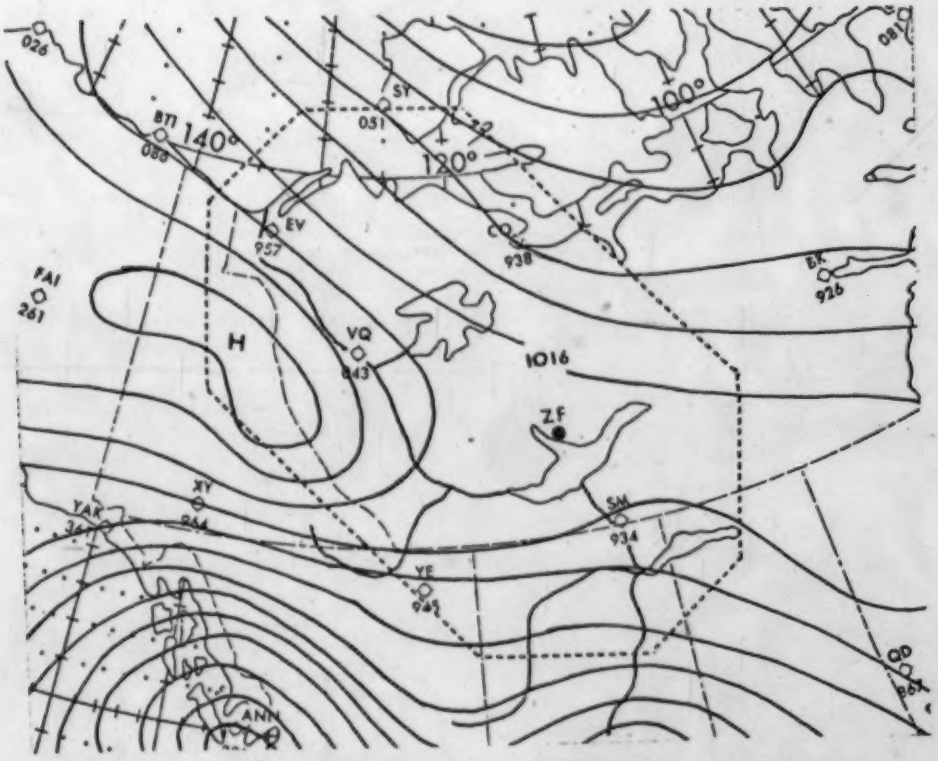
SURFACE MAP TYPE 15



KEY DATE - 12Z, 4 DEC 67

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	64/ 2	27/ 2	18/ 1	19/ 2
MEAN CORRELATION	0.857	0.865	0.847	0.855
MEAN PRESSURE (MSL)	15.81	12.13	20.03	17.06
MEAN PRESSURE GRADIENT	5.00	4.74	5.12	5.26
MEAN MAXIMUM GRADIENT	8.63	7.65	10.67	8.10
MEAN MINIMUM GRADIENT	2.29	2.27	2.19	2.42
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	15/ 32 U/ 24 6/ 18 2/ 14 7/ 2	15/ 50 U/ 18 6/ 9 2/ 9 9/ 5	U/ 38 6/ 31 15/ 19 2/ 6 13/ 6	2/ 36 15/ 18 U/ 18 6/ 9 7/ 9
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 68 2/ 26 3/ 3 6/ 3	1/ 40 2/ 40 3/ 10 6/ 10	1/ 75 2/ 25	1/ 78 2/ 22

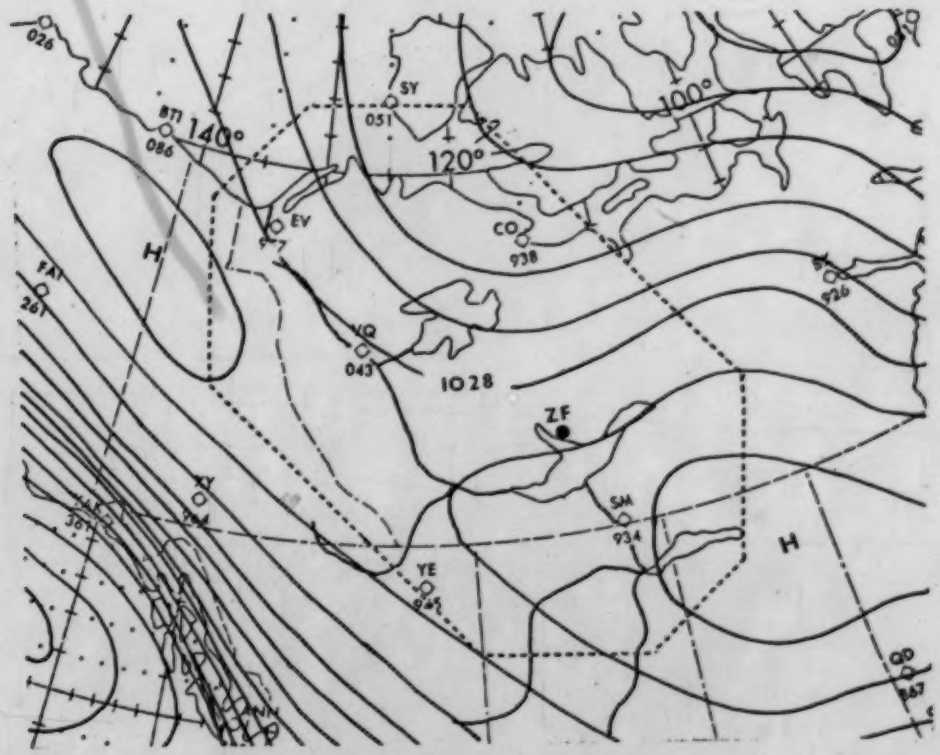
SURFACE MAP TYPE 16



KEY DATE - 12Z, 5 DEC 66

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	61/ 2	26/ 2	26/ 2	12/ 1
MEAN CORRELATION	0.864	0.870	0.860	0.860
MEAN PRESSURE(MSL)	21.72	21.02	22.76	20.97
MEAN PRESSURE GRADIENT	5.15	5.30	5.41	4.27
MEAN MAXIMUM GRADIENT	8.36	8.12	8.74	8.03
MEAN MINIMUM GRADIENT	2.01	2.32	2.13	1.06
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	16/ 35 U/ 29 4/ 15 3/ 6 17/ 4	16/ 39 4/ 30 U/ 17 22/ 9 6/ 4	16/ 35 U/ 25 3/ 15 17/ 10 4/ 5	U/ 56 16/ 33 13/ 11
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 67 2/ 23 3/ 7 4/ 3	1/ 67 2/ 17 3/ 17	1/ 50 2/ 42 3/ 8	1/ 83 4/ 17

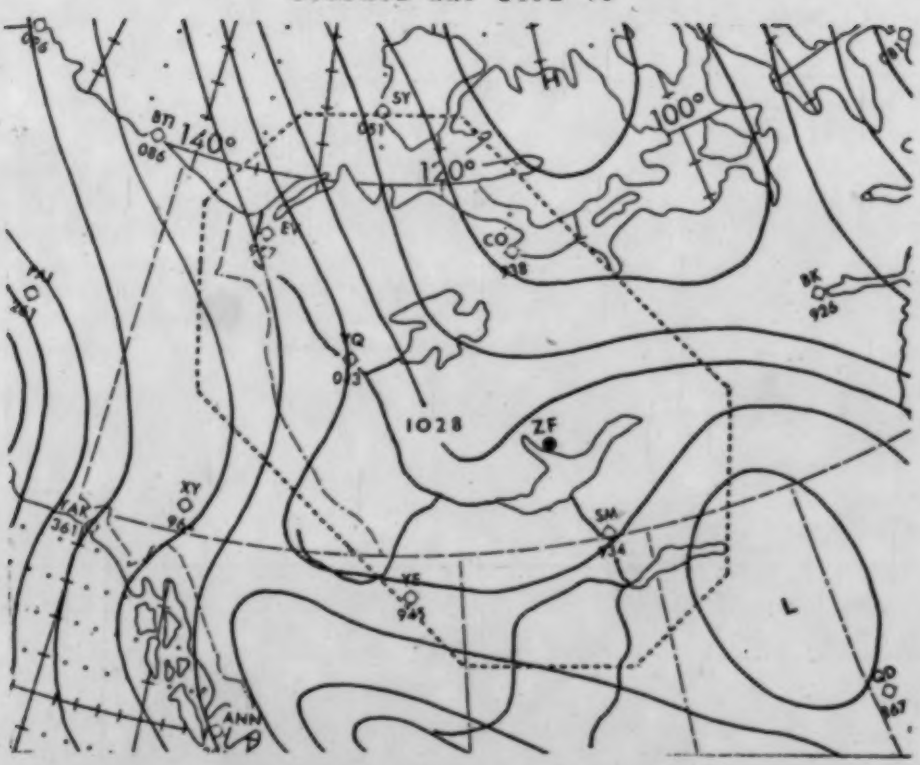
SURFACE MAP TYPE 17



KEY DATE - 12Z, 19 DEC 61

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	55/ 1	14/ 1	23/ 2	18/ 2
MEAN CORRELATION	0.863	0.877	0.867	0.848
MEAN PRESSURE(MSL)	21.68	18.74	23.19	22.05
MEAN PRESSURE GRADIENT	4.55	4.23	4.84	4.44
MEAN MAXIMUM GRADIENT	7.74	7.04	8.03	7.91
MEAN MINIMUM GRADIENT	1.59	1.50	1.79	1.40
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 50 17/ 18 3/ 8 5/ 8 4/ 5	U/ 56 7/ 11 17/ 11 5/ 11 21/ 11	U/ 37 17/ 21 3/ 11 5/ 11 16/ 11	U/ 64 17/ 18 4/ 9 3/ 9
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 84 2/ 10 3/ 6	1/ 83 2/ 17	1/ 79 2/ 14 3/ 7	1/ 89 3/ 11

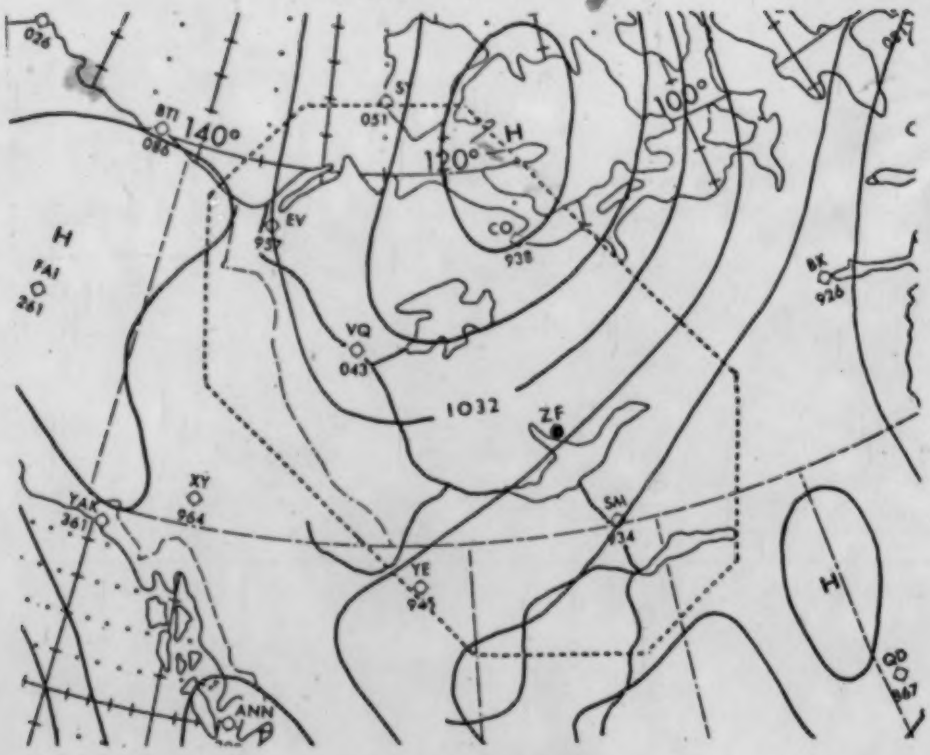
SURFACE MAP TYPE 18



KEY DATE - 12Z, 7 FEB 68

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	50/ 1	19/ 1	13/ 1	21/ 2
MEAN CORRELATION	0.853	0.848	0.862	0.851
MEAN PRESSURE(MSL)	16.54	12.08	18.50	19.36
MEAN PRESSURE GRADIENT	4.39	4.47	4.24	4.40
MEAN MAXIMUM GRADIENT	7.47	7.53	7.14	7.61
MEAN MINIMUM GRADIENT	1.93	1.94	1.82	2.00
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	2/ 52 U/ 22 8/ 9 6/ 9 18/ 9	2/ 50 U/ 38 6/ 13	2/ 33 18/ 33 U/ 33	2/ 60 8/ 20 6/ 10 7/ 10
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 90 2/ 10	1/100	1/ 50 2/ 50	1/100

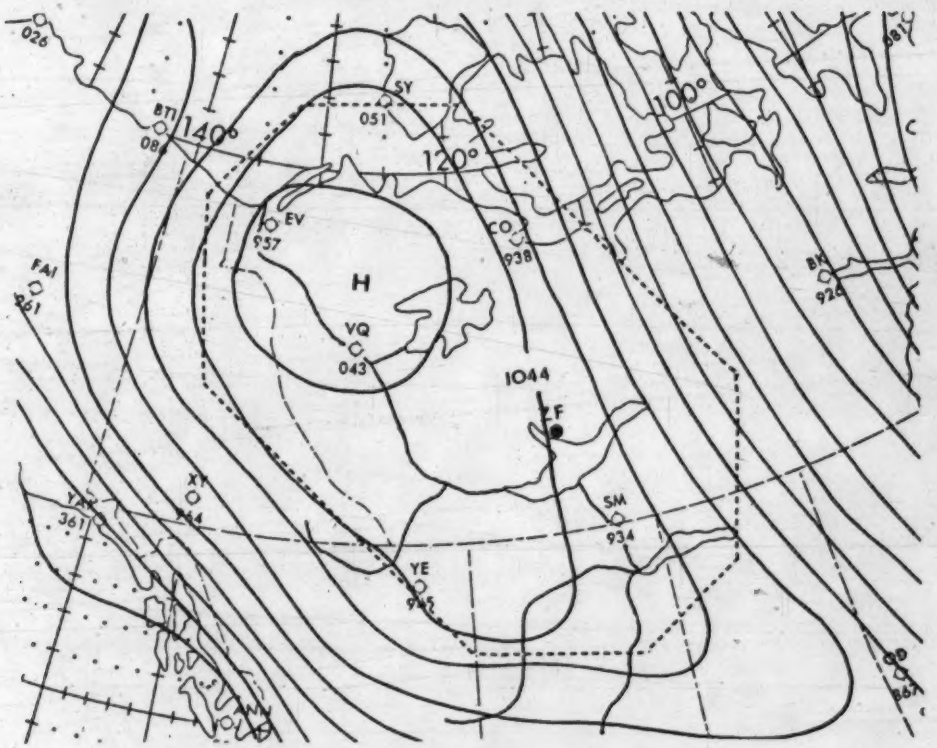
SURFACE MAP TYPE 19



KEY DATE - 12Z, 16 FEB 60

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	46/ 1	16/ 1	18/ 1	13/ 1
MEAN CORRELATION	0.851	0.857	0.839	0.861
MEAN PRESSURE(MSL)	19.71	12.12	22.82	24.74
MEAN PRESSURE GRADIENT	4.64	4.36	5.17	4.25
MEAN MAXIMUM GRADIENT	8.51	7.94	10.35	6.67
MEAN MINIMUM GRADIENT	1.96	2.23	1.80	1.85
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 32 19/ 26 6/ 10 2/ 10 18/ 10	18/ 27 19/ 18 U/ 18 1/ 9 6/ 9	19/ 33 U/ 25 6/ 17 2/ 8 23/ 8	U/ 57 19/ 29 2/ 14
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 70 2/ 26 3/ 4	1/ 78 2/ 22	1/ 63 2/ 25 3/ 13	1/ 60 2/ 40

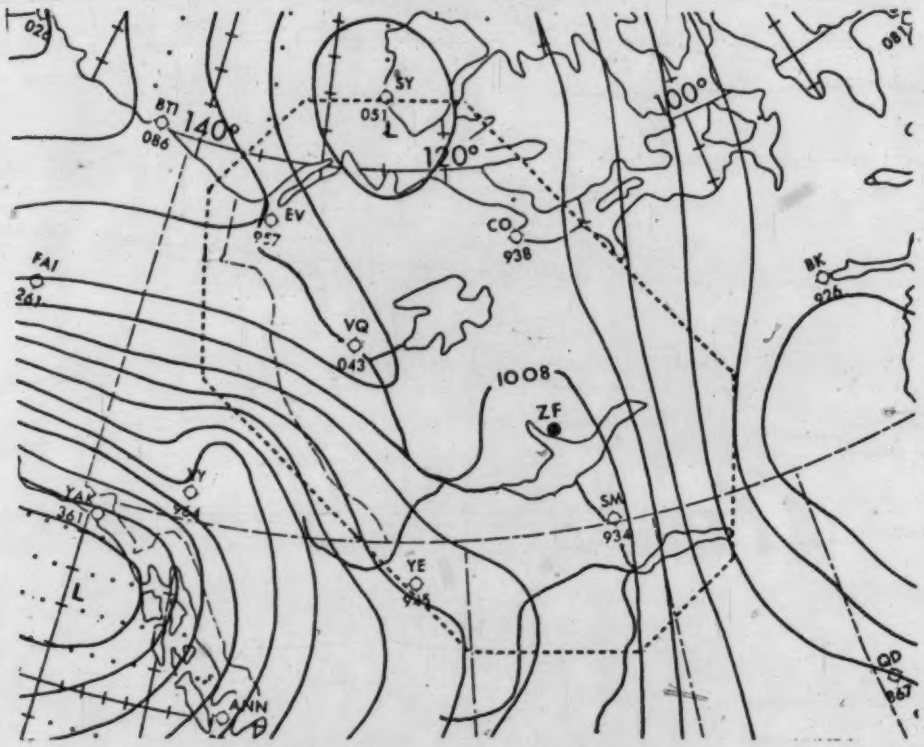
SURFACE MAP TYPE 20



KEY DATE - 12Z, 19 DEC 60

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	34/ 1	11/ 1	11/ 1	12/ 1
MEAN CORRELATION	0.859	0.865	0.851	0.862
MEAN PRESSURE (MSL)	26.57	22.34	28.48	28.70
MEAN PRESSURE GRADIENT	4.35	4.03	4.82	4.20
MEAN MAXIMUM GRADIENT	7.42	6.66	8.57	7.07
MEAN MINIMUM GRADIENT	1.60	1.63	1.58	1.59
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 43 20/ 19 8/ 10 2/ 10 1/ 5	20/ 40 U/ 40 8/ 20	U/ 33 20/ 22 7/ 11 2/ 11 13/ 11	U/ 57 8/ 14 2/ 14 24/ 14
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 82 2/ 12 3/ 6	2/ 67 1/ 33	1/ 83 3/ 17	1/100

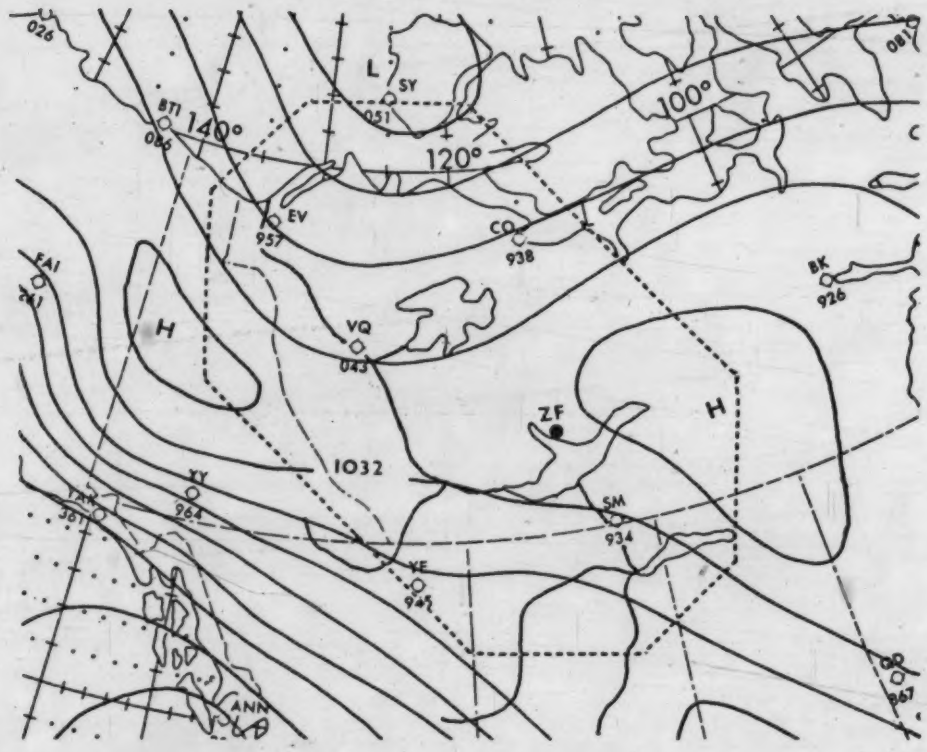
SURFACE MAP TYPE 21



KEY DATE - 12Z, 10 FEB 57

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	32/ 1	10/ 1	5/ 0	18/ 2
MEAN CORRELATION	0.861	0.856	0.857	0.864
MEAN PRESSURE(MSL)	14.57	11.84	18.37	15.02
MEAN PRESSURE GRADIENT	4.64	4.62	4.38	4.71
MEAN MAXIMUM GRADIENT	7.96	8.45	7.80	7.73
MEAN MINIMUM GRADIENT	1.62	1.25	1.71	1.79
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 41 13/ 32 21/ 14 6/ 5 19/ 5	13/ 29 U/ 29 21/ 14 19/ 14 15/ 14	U/ 80 21/ 20	13/ 45 U/ 27 4/ 9 6/ 9 21/ 9
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 84 2/ 16	1/ 83 2/ 17	1/ 67 2/ 33	1/ 89 2/ 11

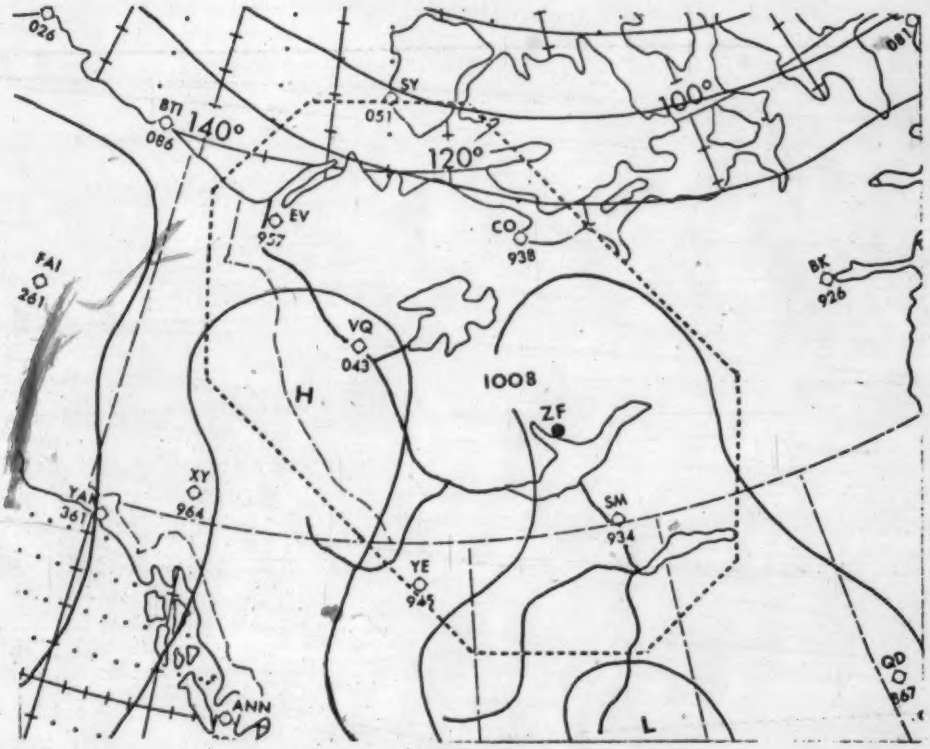
SURFACE MAP TYPE 22



KEY DATE - 12Z, 3 DEC 70

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	21/ 1	13/ 1	6/ 0	3/ 0
MEAN CORRELATION	0.847	0.858	0.822	0.851
MEAN PRESSURE (MSL)	21.40	19.15	27.55	18.85
MEAN PRESSURE GRADIENT	4.40	4.82	3.87	3.68
MEAN MAXIMUM GRADIENT	8.23	9.16	7.04	6.59
MEAN MINIMUM GRADIENT	1.52	1.58	1.57	1.17
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 40 4/ 27 22/ 20 13/ 13	U/ 33 22/ 25 4/ 17 13/ 17 16/ 8	U/100	4/100
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 75 2/ 25	1/ 67 2/ 33	1/100	1/100

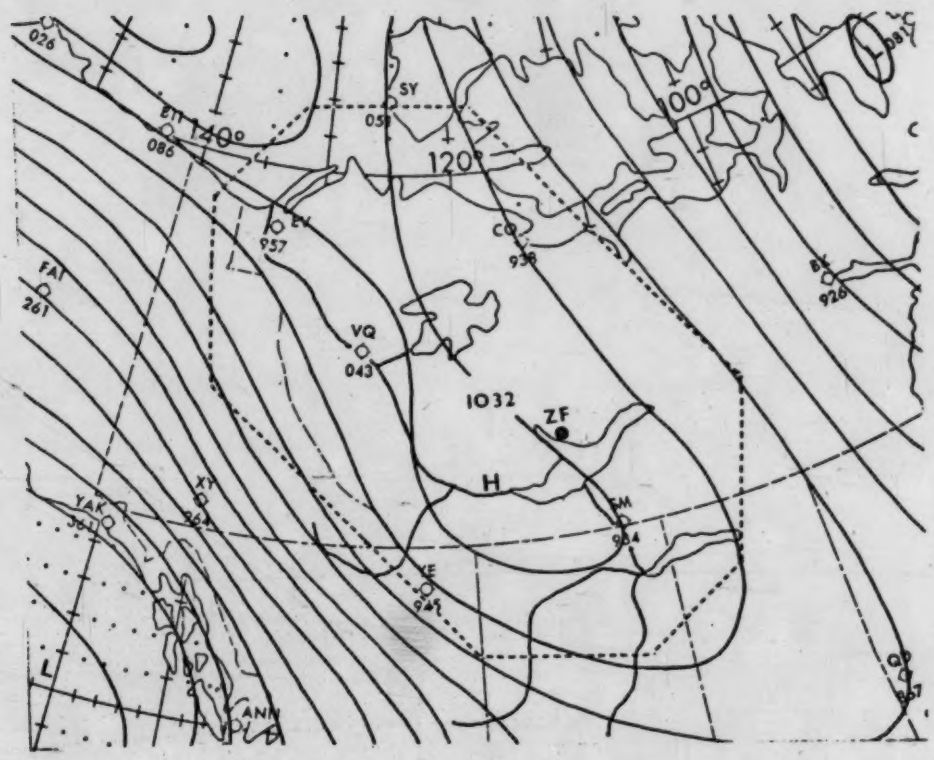
SURFACE MAP TYPE 23



KEY DATE - 12Z, 13 JAN 55

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	17/ 0	7/ 1	8/ 1	2/ 0
MEAN CORRELATION	0.862	0.870	0.861	0.839
MEAN PRESSURE(MSL)	28.40	32.79	27.36	17.20
MEAN PRESSURE GRADIENT	4.04	4.29	3.80	4.13
MEAN MAXIMUM GRADIENT	6.45	6.39	6.22	7.60
MEAN MINIMUM GRADIENT	1.21	1.45	1.11	0.75
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 60 23/ 27 1/ 7 19/ 7	23/ 57 U/ 43	U/ 67 1/ 17 19/ 17	U/100
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 82 2/ 9 4/ 9	1/ 33 2/ 33 4/ 33	1/100	1/100

SURFACE MAP TYPE 24



KEY DATE - 12Z, 19 FEB 68

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	11/ 0	2/ 0	1/ 0	8/ 1
MEAN CORRELATION	0.853	0.858	0.819	0.856
MEAN PRESSURE(MSL)	26.05	24.65	26.95	26.29
MEAN PRESSURE GRADIENT	4.30	3.55	3.88	4.54
MEAN MAXIMUM GRADIENT	8.38	7.10	6.02	8.99
MEAN MINIMUM GRADIENT	1.72	2.25	2.06	1.55
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 45 7/ 18 2/ 18 9/ 9 24/ 9	7/ 50 2/ 50	9/100	U/ 63 7/ 13 2/ 13 24/ 13
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 90 2/ 10	1/100	1/100	1/ 86 2/ 14

SURFACE MAP TYPE U

PERIOD	SEASON	DEC	JAN	FEB
OCCURRENCES/FREQUENCY	1263/ 34	471/ 36	415/ 32	414/ 35
MEAN CORRELATION	0.702	0.697	0.702	0.706
MEAN PRESSURE(MSL)	19.65	17.17	22.01	20.12
MEAN PRESSURE GRADIENT	4.04	4.14	4.10	3.88
MEAN MAXIMUM GRADIENT	7.03	7.25	7.07	6.74
MEAN MINIMUM GRADIENT	1.57	1.63	1.58	1.48
MOST FREQUENTLY FOLLOWING MAP TYPE (MAP TYPE/FREQUENCY)	U/ 52 1/ 6 4/ 4 8/ 4 7/ 4	U/ 54 1/ 7 4/ 6 8/ 4 5/ 4	U/ 50 4/ 7 1/ 7 2/ 5 8/ 4	U/ 51 2/ 6 1/ 5 7/ 5 14/ 5
MOST FREQUENT DURATION (NUMBER OF 12-HOUR PERIODS/FREQUENCY)	1/ 49 2/ 25 3/ 14 4/ 5	1/ 46 2/ 28 3/ 16 4/ 5	1/ 56 2/ 21 3/ 13 4/ 4	1/ 50 2/ 26 3/ 9 4/ 7

APPENDIX 4

THE BRIER P-SCORE

The simple forecast model used in this study is based on the conditional probabilities of ceiling and visibility categories. Root (1962) stresses the importance of resolution and reliability when evaluating weather forecasts that contain numerical probability statements. Forecasts with good resolution have forecast probabilities near zero percent or 100 percent. Those with poor resolution have probabilities near the climatological frequency. Forecasts with good reliability have event forecast probabilities which correspond closely with the relative frequency of the respective events.

In this study, weather events are related to synoptic situations. Hence, successive hourly forecasts for a given situation are not likely to be independent. Thus, where the number of forecasts in a given category is small, a single synoptic situation may account for a large percentage of the cases. This introduces a bias in the observed frequency of occurrence. A stable observed frequency of event occurrence is required to maintain good forecast reliability; this can best be accomplished by having a large number of occurrences. Reliability is important in this study because increased data stratification results in fewer cases available for calculating forecast conditional probabilities. Hopefully, any loss of reliability due to increased stratification can be more than compensated for by better

resolution.

A good verification score to use in this study is the Brier P-Score (Brier, 1950) because it measures both the resolution and reliability of probability forecasts. The score is calculated from the formula

$$P = \frac{1}{N} \sum_{j=1}^{r} \sum_{i=1}^{N} (f_{ij} - E_{ij})^2 , \qquad \text{(A4-1)}$$

where on each of N occasions an event can occur in one of r possible categories, and f_{ij} represents the probability that the forecast was for a category j occurrence. In this study the r categories for each forecast parameter are mutually exclusive and exhaustive, i.e.,

$$\Sigma f_{ij} = 1$$

E_{ij} takes the value of one or zero, depending on whether or not the event occurred, respectively, in category j. The best score for perfect forecasting is a value of zero and the worst value possible is two. This score represents essentially the mean of the squares of the difference between the forecast and observed probability distributions. It is desirable to have a minimum difference; therefore, a good score has a small value.

To isolate the reliability factor in the P-Score formula, it is best to consider each individual category forecast separately, rather than referring to a set of category forecasts. The Brier Score for N forecasts now reduces to

$$B = \frac{1}{N} \sum_{i=1}^{N} (f_i - E_i)^2 , \qquad \text{(A4-2)}$$

and the maximum possible value is one, rather than two.

The forecast reliability is determined by comparing the forecast probabilities against the observed percent occurrences of an event. To facilitate such a comparison, the forecast probabilities can be subdivided into intervals of 10 percent width, so that all probabilities f_i, are expressed in tenths. This results in 11 classes

$$f_i = 0.0, 0.1, 0.2, \ldots f_k, \ldots 1.0 ,$$

where f_1 contains probabilities from 0.0 to 0.04; f_2 from 0.05 to 0.14 ... etc.

Consider a class "k" which consists of M_k probability forecasts of a category, and a total of R_k event occurrences. The ratio of event occurrences to probability forecasts for the k^{th} class is

$$\phi_k = \frac{R_k}{M_k} \qquad \text{(A4-3)}$$

For example, if the ceiling category A occurred seven times, and was forecast at a probability of 80 percent to occur ten times, then

$$\phi_9 = \frac{7}{10} = 0.7 .$$

From (A4-2), the contribution to the Brier Score for the event occurrences is $1/M_k(f_k-1)^2R_k$, and the contribution for non-occurrences is $1/M_k(f_k-0)^2(M_k-R_k)$. The Brier Score for the k^{th} class becomes

$$B_k = (f_k - 1)^2 \phi_k + f_k^2 (1 - \phi_k). \qquad \text{(A4-4)}$$

By adding and subtracting ϕ_k^2 and rearranging terms, (A4-4) can be

written as

$$B_k = (f_k - \phi_k)^2 + \phi_k (1 - \phi_k). \qquad \text{(A4-5)}$$

The score for the whole set of N forecasts of a category is the weighted average of the scores obtained in the 11 classes

$$B = \frac{1}{N} \sum_{k=1}^{11} M_k B_k = \frac{1}{N} \sum_{k=1}^{11} M_k \{(f_k - \phi_k)^2 + \phi_k (1 - \phi_k)\} . \qquad \text{(A4-6)}$$

In this form the Brier-score formula is separated into its reliability and resolution components.

The reliability term, $(f_k - \phi_k)^2$, measures the difference between the forecast probability f_k and the relative frequency of occurrence of the event, ϕ_k. A root-mean-square error (RMSE) in reliability can be defined from (A4-6) as

$$\text{RMSE} = \frac{100}{N} \sum_{k=1}^{11} M_k (f_k - \phi_k)^2 , \qquad \text{(A4-7)}$$

with the values expressed as percentages.

The second term in (A4-6) expresses the resolution of the forecasts and depends only on the value of ϕ_k. It has a minimum value when ϕ_k is either one or zero. This happens when the event always occurs when forecast at 100 percent probability, or when the event never occurs when forecast at zero percent. When $\phi_k = 0.5$, the resolution term has its maximum value of 0.25.

In this study Brier Scores are used to verify probability forecasts based on pure seasonal climatic frequencies, as well as those based on climatic frequencies that have been stratified by map type and pressure gradient. To compare results, a simple skill score

is used that gives the percentage improvement of stratified-climatology forecasts over pure climatology forecasts. It is calculated from the formula

$$S = 100\ (1 - sB/cB),$$

where sB is the Brier Score for stratified forecasts and cB is the score for climatology forecasts.